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How TOUGH

OVER 5 YEARS ON THE JOB — CONTINUOUSLY! That's the record of this 5 hp motor. Heat, moisture and chlorine fumes make this chemical location a real test of motor value.

EXPLOSION-PROOF MOTORS. Designed to give absolute safety in the most dangerous locations. Multiple seals isolate inside of motor from outside air. Approved for Class I, Group D locations.

SPLASH-PROOF MOTORS. Sturdy, rigid construction with ample protection from top or side directed particles or liquids. Suitable for outdoor use. Available with 50°C or 40°C temp. rise guarantee.

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A CENTURY OF SERVICE to Industry THAT MADE America Great

Fig. 190—150-pound Iron Body Bronze Mounted "Irenew" Globe Valve. Has screwed ends, union bonnet and regrindable, renewable, wear-resisting "Powellium" nickel-bronze seat and disc.

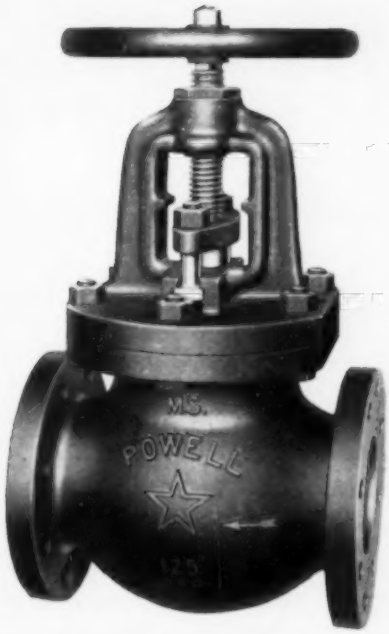


Fig. 241—Large 125-pound Iron Body Bronze Mounted Globe Valve. Made in sizes 2" to 16", inclusive. Has outside screw rising stem, bolted flanged yoke and regrindable, renewable bronze seat and disc. Also available in All Iron for process lines.

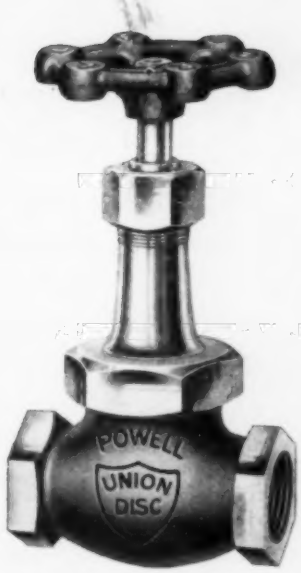


Fig. 150—150-pound Bronze Globe Valve with screwed ends, union bonnet and renewable composition disc.

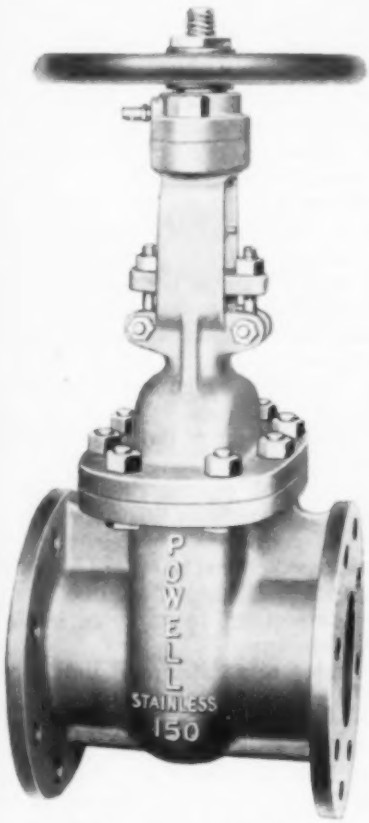


Fig. 2453-G—New, standard 150-pound Stainless Steel Gate Valve with outside screw rising stem, bolted flanged yoke-bonnet and taper wedge solid disc.

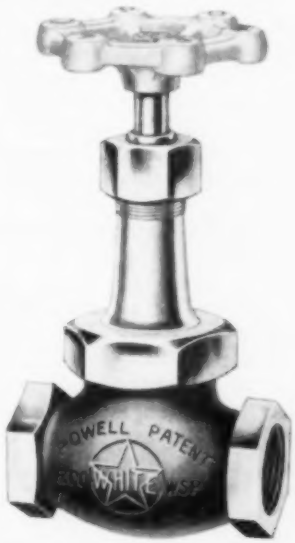


Fig. 1708—200-pound Bronze Globe Valve with screwed ends, union bonnet, renewable, specially heat treated stainless steel seat and regrindable, renewable, wear-resisting "Powellium" nickel-bronze disc.

Fig. 1793—Large 125-pound Iron Body Bronze Mounted Gate Valve. Made in sizes 2" to 30", inclusive. Has outside screw rising stem, bolted flanged yoke and taper wedge solid disc. Also available in All Iron for process lines.

VALVES

WATCHING WASHINGTON

R. P. McBride, EDITORIAL CONSULTANT
Donald C. Loomis, WASHINGTON CORRESPONDENT

Chamber of Commerce makes recommendations before Ways and Means Committee for comprehensive changes in tax law . . . Scientific Research Board favors increases in salary levels for senior scientists in the federal service . . . Atomic Energy Commission announces achievements in atomic activities . . . War Assets Administration makes study of industrial potentiality of Basic Magnesium plant . . . New group appointed to study safety methods for handling ammonium nitrate . . . Rubber companies want to control information and techniques developed in synthetic rubber operations

Tax Recommendations

SPEAKING for business the Chamber of Commerce of the United States presented an elaborate set of recommendations at hearings before the Ways and Means Committee of the House which is considering a complete revision of the tax laws. Basically the Chamber emphasis is on the question which they put graphically, "How many days a week must the individual work for his government?" They proceed from this with the discussion as to how big a cut the Government can take and how big a cut it should take from the personal income of citizens.

Recommended by the Chamber are over twenty technical amendments relating to administration. The specific changes urged deal with individual income, corporation income, depreciation, state and gift taxes. Almost ignored is the question of competition between individually owned enterprise and so-called "cooperatives" which do business on an extended scale with non-members.

Hearings will continue before the Committee at intervals through October, and perhaps longer. It is hoped that comprehensive tax revision law will be ready for House consideration at the beginning of the regular session in January.

Scientists' Salaries

CORDIALLY welcome in Washington is the recommendation of the President's Scientific Research Board at the point where it urges increase in top salary levels for senior scientists required in Uncle Sam's service. It points out, "The general Civil Service pay ceiling is $10,000, whereas outstanding scientists and research directors in industry command much higher salaries."

The Board recognizes that War and Navy Departments now may pay up to $15,000 per year for a total of 45 scientists. From this it argues that comparable changes for those working on other government investigations are needed.

Reports of this character are seldom published until after top policy at the White House has been determined. Hence, it is assumed the President agrees with this general recommendation. Consequently there were general forecasts that legislation for better salary ranges for technical personnel can be expected to have support of the Administration.

Oil Notes

RECENT announcements from the Department of Agriculture have included one technologic note on soybean oil and one economic note on cottonseed oil. Of interest to soybean processors is the announcement that soybeans in storage do not diminish in oil content.

Price differential between cottonseed at the crusher and ultimate consumer prices for products produced from cottonseed have approximately doubled in the past decade. An example cited by Acting Secretary of Agriculture Brannan was about 10 cents per pound spread from crude cottonseed oil at the mill to the price of shortening and margarine in one-pound packages at retail ten years ago. Today these price differences, based on average retail prices advertised in Washington, D. C., are about 20 cents per pound. Milling of cottonseed is currently estimated to cost about $17.50 per ton of seed, according to a National Cottonseed Products Association cost study in progress, also cited by Mr. Brannan.

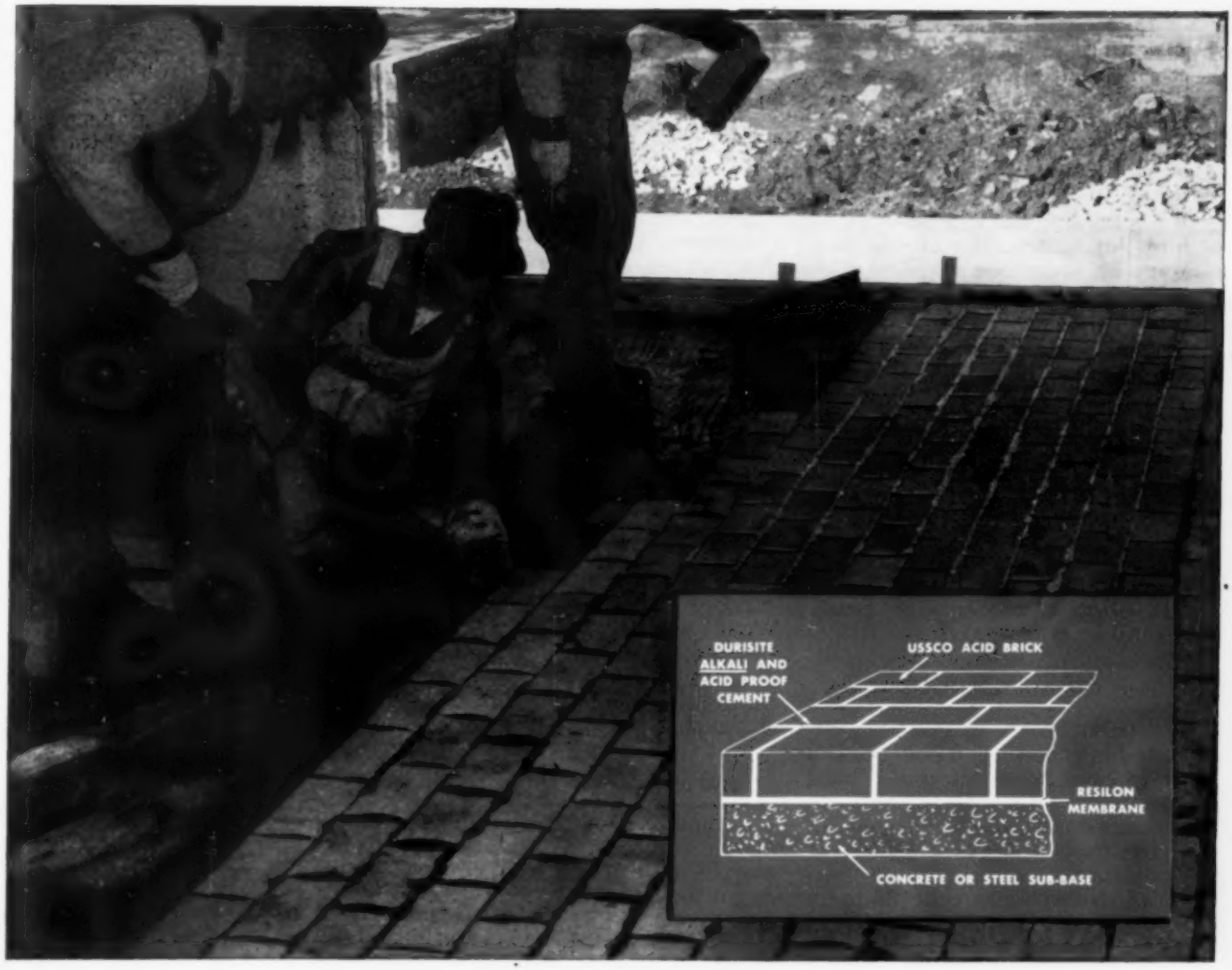
Atomic Activities

NEAR Labor Day the Atomic Energy Commission made a number of announcements of recent achievements and future plans. Perhaps the most important achievement was a new type nuclear reactor. The new unit, known as the "fast reactor," is a controlled version of the atomic bomb itself. It is the first reactor to employ the fission of the man-made element, plutonium, instead of normal uranium, and it is the first to use fast neutrons. The fast reactor is expected to speed and broaden atomic energy research, particularly in the design of future experimental reactors for power generation.

Announcement of the international availability of radioisotopes which are byproducts of Atomic Energy Commission operations in this country has received considerable publicity. Expanded medical and biological research in international fields should be of no small importance to improved health in this country.

Naming of a Safety and Industrial Health Advisory Board by the Atomic Energy Commission was the first step in its long-range program in this direction. Individual members of the ten-man Board, under the chairmanship of Sidney J. Williams, will prepare reports on the phases of the health and safety problems in which they specialize.

Long-range study of the survivors of the atomic attacks on Hiroshima and Nagasaki also will be undertaken jointly by the Atomic Energy Commission and the National Research Council. A committee will implement President Truman's directive "to undertake a continuing study of the medical and biological effects of the atomic bomb on man". A full-scale research pro-



It takes a floor like this to handle both acids and alkalies

"Acid-proof" floors don't stand up too long when called upon to handle both acids and alkalies. The average corrosion-proof cement falls down badly under such conditions. That's why Oneida, Ltd., installed in their new plant a "U. S. Stoneware Specification Floor."

Their new floor, illustrated and sketched above, will give long and trouble-free service under exposure to strong and weak alkalies, strong and weak acids, oils, solvents or water. Cold water or live steam will leave it unruffled. It will stand up under heavy traffic.

Durisite cement is unique in that it will handle *both* alkalies and acids; it sets quickly by internal chemical reaction; makes a tight, non-porous bond between brick. The resilon membrane (a chemically resistant resinous thermoplastic) forms an impermeable barrier between brick and sub-base.

Once installed, a "U. S. Specification Floor" can be forgotten. It is truly "the finest floor you can buy."

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AKRON 9, OHIO

gram is planned in Japan under competent American physicians.

Bikini Atoll is again safe for human life, according to two medical consultants recently returned from the site of the 1946 atomic bomb tests. Although much radioactivity was found still present, it was so widely distributed that residence for as long as a year could be contemplated.

University of Chicago was rumored as the successor to Monsanto Chemical Company as the new operator of the Clinton Laboratories at Oak Ridge, Tennessee. Atomic Energy Commission confirmed the discussion and it was later announced that the University would take over.

Operation of the Oak Ridge plants was approaching a state of industrial "normalcy." Contract negotiations between labor and management were said to be unsatisfactory. Apparently the novelty of working at an atomic installation is wearing off.

Trade Charter Drafted

UNITED STATES delegation at Geneva has announced that 17 nations representing two-thirds of the world commercially have unanimously approved a draft charter for the proposed International Trade Organization. American enterprise knows the form in which this charter went to Geneva from acquaintance with State Department proposals. It has not yet seen the draft agreed upon.

The 4,000-word document prepared during seven months of negotiation in London, New York, and Geneva still has two important hurdles to jump. Nations which agreed to it at Geneva must present it to the rest of the 60 or more countries which, it is hoped, will come into the new international body. It is expected this will occur in November at Havana when about 60 nations will have delegates attending what is expected to be an all-winter conference.

The charter also must have Senate review as a treaty or Congressional approval as a new law. This is perhaps the highest hurdle of all for it to jump.

Monopoly Charges

PENT UP enthusiasm in the Anti-Trust Division of the Department of Justice is now released in numerous indictments and efforts to get indictments of important industry groups. In some cases Justice is seeking only civil action. In other "more flagrant" cases criminal and civil procedings are both under way. Numerous additional cases can be expected. The Division has done little else but prepare for these since V-J Day, and it is understood that there are dozens of cases ready for presentation as fast as favorable situations can be developed.

A flood of these cases does not represent any sudden new postwar wickedness in business. It indicates, rather, that the Division has now had time to recover from its wartime interruption of normal investigations and prepare specific programs with what it hopes will be adequate evidence to get a reasonable number of convictions. It is likely this sudden activity is timed in the hope that Congress will be more generous with appropriations next year. Also possible is the thought that these activities may be helpful to the administration in an election year when the "monopoly" whipping boy always makes good "copy."

Process industry spokesmen about Washington are quietly wondering whether any of their groups are included in the program. Naturally the Department of Justice is not talking on that phase of the question.

Insecticide Rules

REGULATIONS for administering the new Federal insecticide law were announced in tentative form early in August and made the subject of a hearing on August 25. A few industry spokesmen appeared to suggest changes in these rules of practice.

Principal fear expressed by industry spokesmen was that an over-literal application of either the law or these regulations might produce harsh or impractical results. These spokesmen asked that some of the details be so modified as to preclude that result. In general, comments favored the bulk of the regulations as printed in tentative form.

Protestants and others interested were given until September 8 to file further comments. It was planned that before the end of September final regulations would be promulgated by printing in the Federal Register. The effective date will be 30 days after that printing.

Two major novelties apply under the new law. One requires registration of materials used in pest control. The other requires coloring of certain poisons.

Many materials used for pest control must be registered with the Insecticide Division of the Department of Agriculture before Christmas, that is, within six months after enactment of the law. Registration proviso applies to insecticides, fungicides, herbicides, rodenticides, and all types of control materials, many of which were not regulated by the earlier law. However, registration of old materials in the class of insecticides and fungicides is not required to be completed until June 25, 1948, one year from the date of enactment.

Certain arsenic and fluorine containing compounds which are specified in the regulations must be colored to avoid possible confusion with food products when in the hands of the ultimate consumer. Other insecticides not now specifically required to be colored may be added subsequently following formal hearings.

"Defense" Begins

DEPARTMENT of National Defense began functioning as such with the swearing in of Secretary Forrestal in mid-September. The Department now functions through the three major divisions on an equal footing: Army, Navy and Air. Communications to the new consolidated departments can be continued as formerly, since the changeover in detail will take place gradually over many months.

Henderson Disposal

CRITICAL question of power cost, which has been a major obstacle to War Assets Administration officials trying to dispose of the Basic Magnesium plant at Henderson, Nevada, may be answered by the first of November. At that time, WAA expects to produce figures on power costs for chemical companies and others who can't get down to cases without having firm cost figures for the long pull.

What WAA officials would like to see is development of a number of chemical processing operations based on Henderson's chlorine production capacity. At present, the Stauffer Chemical Co. leases these facilities and is producing 130 tons of chlorine a day, plus quantities of caustic soda. Facilities available could be readily expanded to 200 tons a day. At present, half a dozen other companies occupy portions of the plant on five- and ten-year leases.

WAA officials are now studying the first parts of an appraisal of the industrial potentialties of the Henderson plant. The report notes that Henderson's facilities and geographical position make it a natural for production of chemicals and other products for the expanding industries of Los Angeles and southern California.

A joint hearing of Congressional subcommittees charged with investigating the national defense program

As the white outline indicates, a standard unit of much greater frame size would be required to do the work of Speedaire.

Calcimine can't slow up SPEEDAIRE

DUST accumulates quickly on everything in this New Jersey Calcimine plant, but it does not impair Speedaire's capacity or efficiency. Speedaire was selected for this job, over a conventional worm gear drive, first, because Speedaire's powerful fan keeps the internal surfaces clean and cool, and second because of the saving in space, weight and cost. The money saved was $117.00.

Speedaire is Cleveland's new fan-cooled worm-gear speed reducer. Because it is fan-cooled, Speedaire will do more work—will deliver up to *double the horsepower* of standard worm units of equal frame size, at usual motor speeds. It can be installed economically on many applications where other types have been used heretofore—giving you the advantage of a compact right-angle drive. Speedaire gives the same long, trouble-free service characteristic of all Clevelands.

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Speed Reducers

and surplus property disposal held hearings at Henderson in August. The committee staff is engaged in writing a report which will contain suggestions on methods of disposal.

New Group Studies Nitrate

THE INTER-AGENCY committee studying hazards of ammonium nitrate has another group officially sponsored by the government. At a special meeting of the President's Conference on Fire Prevention a committee of five was appointed to "carry out an exhaustive study of the problem of control of ammonium nitrate combustion aboard ship."

First report of the inter-agency committee sharply underscored its conclusion that the most common danger in handling ammonium nitrate aboard ship is fire involving combustible containers or combustible material present in the same hold.

The inter-agency group's recommendations were: That the Coast Guard require fire watches on ships loading or unloading ammonium nitrate fertilizer; that the Coast Guard suggest methods of preventing and extinguishing fires on nitrate-carrying ships and in waterfront storage facilities; as an interim measure, that the Coast Guard continue its order prohibiting loading of ammonium nitrate at any facility other than those approved by the Coast Guard; and that local port authorities secure ordnances to prevent smoking in waterfront areas.

This report is to be followed by separate ones covering hazards in land transportation (which the group regards as negligible) and results of physical and chemical tests now being conducted to learn more of the chemistry of ammonium nitrate and the conditions under which it becomes potentially dangerous.

Nitrate Fertilizer Needed

THE INTER-AGENCY committee report states that "the program of relief of devastated countries and the economy of the American farmer will be adversely affected if ammonium nitrate fertilizer is not utilized. The committee feels that with proper precautions and adequate supervision of all phases of loading, stowage, and transportation on board vessels, ammonium nitrate fertilizer can be transported with reasonable safety."

One member of the inter-agency committee refused to sign the report. Col. F. H. Miles, Jr., of the Army-Navy Explosives Safety Board, felt the report left open the possibility of too-early relaxation of the present Coast Guard emergency order which forbids loading or unloading ammonium nitrate except at isolated facilities. He contended that until more is known about conditions under which ammonium nitrate will detonate, loading from isolated docks must be retained. He named a dozen or more specific isolated loading points on the Atlantic, Gulf and Pacific coasts that can be used for this purpose.

As a result of the inter-agency committee's recommendations, the Interstate Commerce Commission now requires that ammonium nitrate containers (bags) carry the yellow label which indicates an oxidizing material which should not be exposed to fire. Up to August 21, nitrate had been classified as an oxidizing material but had been exempt from the yellow label.

ICC has not yet taken action on the recommendation that it set up specifications for ammonium nitrate containers. A container-industry committee is now studying the problem of making bags either fire-proof or fire-resistant. ICC won't write specifications until this group concludes its studies.

Synthetic Rubber Program

WITH THE ISSUANCE of its long-anticipated revision to the order setting specifications for compulsory consumption of synthetic rubber in rubber products, the Office of Materials Distribution of the Department of Commerce estimates that synthetic rubber consumption will be brought down to one-third of the total natural and synthetic processed in the United States.

This proportion, which approximates 250,000 tons a year, was the figure recommended as a minimum by the report made nearly two years ago by the Inter-Agency Committee on Rubber (known as the Batt report.) Currently, synthetic rubber accounts for about 40 percent of all rubber consumed in the United States.

The new order concentrates the consumption of synthetic rubber in auto tires and tubes, and ends the forced consumption of synthetic in some 30,000 non-transportation rubber products.

On the legislative front, all has been quiet pending the return of Congressional committees from overseas junkets. The House Armed Services committee, under the chairmanship of Rep. Paul W. Shafer (R. Mich.) was expected to be back by mid-October in time to prepare for visitations to rubber plants, and hearings to be held in Akron in early November. The committees plans have called for writing of a bill to be introduced at the beginning of the session in January.

Cross-Licensing Struggle

RUBBER COMPANIES have been negotiating with RFC to secure early termination of the agreement by which they are required to share all information and techniques developed from their synthetic rubber operations.

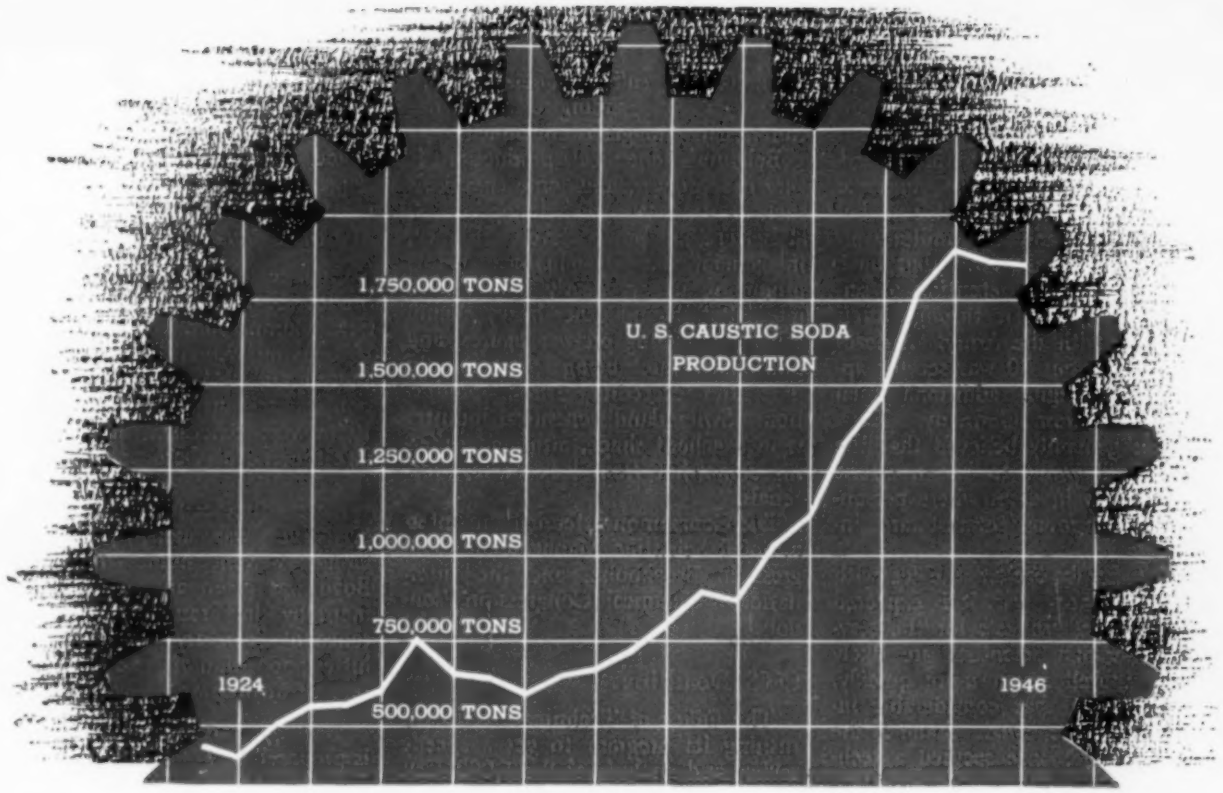
Manufacturers admit a natural reluctance to push research programs without the incentive of profiting by the results of their own work. They claim that research will be slowed until they can resume normal competitive relationship. Reports are current that a number of companies are on the verge of discoveries which they won't be apt to push until they can be sure they won't have to hand it over to competitors.

Germans to Industry

THE ARMY has recently opened the inter-agency bottleneck that heretofore prevented private companies and universities from retaining German scientists brought to this country originally to work on military projects. As of the middle of September, seven scientists have signed a contract drawn up by the War Department under which the men work. They are working for: Heintz Mfg. Co., Philadelphia; Victor Mfg. and Gasket Co., Chicago; Hydrocarbon Research Co., New York; Pacific Car and Foundry Co., Renton, Wash.; University of North Carolina, and University of Texas.

These men are now on the payroll of the organizations with which they've signed contracts. But they're still under the security surveillance of intelligence officers of the Army area headquarters nearest their residence and place of work. State Department has looked the other way, and is not granting permanent visas to these men. Technically, they're still wards of the War Department.

In addition to Germans already in this country (the total at one time was about 500, and now is about 450), it is anticipated that additional scientists will be permitted to enter the country under the new arrangement to work for non-military organizations. Officials report that some men still in Germany have been cleared for security purposes by Army intelligence in Germany—and other men, sought by American industry, will be cleared. In each case, however, it must be proved to the satisfaction of the War Department that



In gear with American Progress

The huge increases in volume and the vastly superior quality of American production of Paper, Rayon, Textiles, Chemicals, Soap, Petroleum and numerous other essentials are reflected in the records of alkali manufacture. Caustic Soda, for example, is identified with basic processes in all of these industries. Its production figures are indicative of the close ratio to those of leading American industries.

Columbia, since the turn of the century, has been one of the nation's leading producers of Caustic Soda, other basic alkalies and related products . . . in support of the constant progress of its customers.

Pittsburgh Plate Glass Company • Columbia Chemical Division, Fifth at Bellefield, Pittsburgh 13, Penna. . . . Chicago • Boston • Cleveland • New York • Cincinnati • St. Louis • Minneapolis • Charlotte • Philadelphia • San Francisco

USE OF CAUSTIC SODA BY U. S. INDUSTRIES (IN TONS)

CHEMICALS
1923— 70,000
1937—158,000
1946—405,000

RAYON & FILM
1923— 40,000
1937—186,000
1946—408,000

PETROLEUM REFINING
1923— 40,000
1937— 97,000
1946—150,000

LYE & CLEANSERS
1923— 55,000
1937— 48,000
1946—110,000

MISC.
1923—288,000
1937—301,000
1946—559,000

TEXTILES
1923— 40,000
1937— 44,000
1946—108,000

PULP & PAPER
1923— 3,000
1937— 48,000
1946—110,000

COLUMBIA CHEMICALS

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PITTSBURGH PLATE GLASS COMPANY

the importation of these men is in the interests of the security of the United States.

While the Office of Technical Services of the Department of Commerce has been the theoretical liaison between industry and the military in this operation, those firms that have secured approval for retention of scientists have gotten it through their connections with the Army. A deadline of September 30 was set for approvals for bringing additional men to the U. S. from Germany. However, it is generally believed that the deadline will prove to be an elastic one, especially in cases where personnel of exceptional interest are involved.

Having finally broken the ice with the first few approvals, it is expected that additional requests for the services of German scientists are likely to be approved much more quickly. Officials report that considerable interest has been renewed. Some of the companies that have secured a technical man under the new arrangement are reported to be interested in securing the services of additional men.

European Chemical Output

CHEMICAL production of many European nations now compares favorably with their prewar output, Dr. Charles C. Concannon, chief of the Chemicals & Drug Division of the Department of Commerce reported upon his return from a two-months tour of half a dozen European countries.

In a talk to the inter-agency chemical statistics committee, Dr. Concannon reported that with the nationalization of the British coal industry already accomplished, and the scheduled nationalization of the gas and steel industries, Britain's chemicals industry will be from 50 to 75 percent nationalized. However, Dr. Concannon declared there seemed to be little likelihood that Imperial Chemicals Industries, England's giant chemical producer and the largest private enterprise in the country, would be taken over by the government. Chemical production in Britain is generally high, he said, although soda ash production, for instance, was down because of the shortage of coal.

In Sweden, production of crude arsenic is outstripping the country's capacity to produce the refined arsenic which the United States would like to have. Holland, according to the Commerce official, no longer exports nitrogen, but is importing it from the United States. However, the country's chemical industries are doing well, although the country's recovery is likely to suffer financially if the current rate of spending to finance the Indonesian struggle is continued.

Belgium's chemical production is very near prewar, and some chemicals such as soda ash are being produced at better than prewar levels. France, in general, has its chemical plants producing at very nearly the 1936-38 rate. Potash and other heavy chemicals are equalling pre-war figures, and phosphates are being produced in quantities exceeding prewar production. Switzerland's chemical industry is in excellent shape, although suffering somewhat from lack of raw materials.

Dr. Concannon attended the International Scientific Management Congress in Stockholm, and the International Chemical Congress in London.

OTS Deadline

The Office of Technical Services is rushing its program to get a speedy review and analysis of the 5,000 reels of microfilmed German-language documents containing German scientific and technical data. About 40 percent of the material yet to be read and abstracted pertains to the chemical industry, according to unofficial estimates.

While the deadline seems a long way off—June 30 of next year—OTS proceeds on the assumption that its life will end on that date, and the mass of material to be identified and reviewed under difficult circumstances makes speed imperative.

First step has been the publication, in two special issues of the weekly "Bibliography", of the titles of the 5,000 reels. This provides for general distribution of the presently-available information, and makes it possible for anyone to order copies of any microfilm reel for his own use.

In the organized program to have these German-language documents made available in English, more than 150 offers of assistance have been received by OTS from technical societies, trade associations, universities, private companies, and industrial research laboratories.

By the end of September, OTS planned to have placed in the hands of reviewers about 500 reels for a first reading. Through use of a printed check-sheet, it hopes to have quickly from volunteer reviewers an evaluation of the material sent them. In the meantime, four indexes to the 100,000 OTS reports published from January, 1946, through March of this year have been published. As one of its series of special indexes covering particular fields or materials, OTS has published an index to the 8,000 de-classified reports originating in the Office of Scientific Research and Development.

Minor News Glimpses

Organic chemicals data for synthetics are now available from U. S. tariff Commission in its Report No. 157, giving United States production and sales in 1945. Preliminary production figures on such synthetics for 1946 were scheduled to appear before the end of October.

A new director for the U. S. Bureau of Mines was named shortly after Congress went home. Dean James Boyd was given an interim appointment by the President, on the insistence of Secretary Krug, despite the bitter opposition of John L. Lewis who regards Boyd as anti-labor.

Underground storage of natural gas is proposed by Michigan Consolidated Gas Co. It has asked Federal Power Commission to authorize construction and operation of a special pipeline and storage facilities to give a reserve for winter peak-load purposes. The gas would come from the Austin, Texas, field at seasons when the load on the transmission lines is small for storage near Detroit.

Explosives control by the U. S. Bureau of Mines, a war-time security measures, terminated on July 25 when Federal Explosives Act was suspended. Licenses are no longer required for normal manufacture, handling and use of explosive material.

Common stock of General Aniline and Film Co. is to be held by the Alien Property Custodian for some time. The rumor that this stock was to be offered to the public for sale shortly is denied categorically at the Department of Justice.

Alcohol manufactured from surplus potatoes will be encouraged by the Department of Agriculture in order to utilize potatoes bought under price support programs. However, priority will be given to cold storage, charitable use, and export.

Statistical agencies of the Government find it necessary to economize sharply under limited appropriations for the current fiscal year. Significant cutback is being made in statistical work of four major bureaus: Bureau of Labor Statistics, Census Bureau, Bureau of Mines, and Bureau of Agricultural Economics.

CHEMICAL ENGINEERING
with CHEMICAL & METALLURGICAL ENGINEERING

ESTABLISHED 1902 OCTOBER 1947 SIDNEY D. KIRKPATRICK, Editor

Resources for Research

IN MANY RESPECTS the first volume of the report to the President on "Science and Public Policy" is the most important statement of politico-scientific principles since the famous Bush report of 1945. If the four that are to follow prove equally challenging, the President's Scientific Research Board will have helped tremendously in clearing the way for a national science policy and program already long overdue. The report speaks with authority and apparent understanding of problems that have plagued Congress since the early days of the first Kilgore bill. But it also poses some basic issues that the nation as a whole may not yet be ready to accept.

First of these is the question of proper balance among the three parties to such a program—government, industry and education. They are the legs of the stool that must support any sound public policy on science. The present report, it seems to us, may be putting too much emphasis on the role of government, and particularly the appropriation of federal funds. It is easy to talk about maintaining freedom of scientific inquiry but if we permit the government to supply all the money, it is inevitable that we can expect governmental control and domination. The report recommends that by 1957 we should be devoting 1 percent of the national income to research, that expenditures for basic studies should be quadrupled, that health and medical research should be tripled and that industrial research should be doubled.

But the limiting factor in any such program may well be manpower rather than money. A subsequent volume in the series will deal exclusively with this problem, but in the meantime the current report emphasizes the double-barreled job that must be done by the universities both in training men for research and in actually pioneering with basic studies. Fifteen thousand more science teachers are needed to restore the prewar student-teacher ratio in schools where today more than 600,000 men and women are enrolled for science and engineering majors. Enactment of a law establishing a National Science Foundation is but one part of this program. It will help finance basic research in the universities. It will be ready to take up the slack in supporting scholarships when GI benefits expire.

The desired and necessary balance between basic and industrial research cannot be attained without industry shouldering its important share of the burden. To some extent this can be stimulated by changes in corporation tax laws to provide incentives for research expenditures, especially by smaller companies. Means must be found to promote research consciousness and wherewithal in industries already loaded down with obsolete equipment and processes. But most of the money will have to come from profits—past, present and prospective. In a world drifting toward socialism and communism, this country can set a great example by recognizing the fact that science supported by the profit motive is largely responsible for the type of progress we proudly call the American way of life.

The United States needs a unified, comprehensive policy on scientific research and the support of science. These reports of the President's Board can help define our scientific and political objectives, at the same time helping us organize our national resources for research. But a national scientific policy and program cannot become effective if left entirely in government hands. On each of us who shares in any way in this program rests responsibility for helping to marshal adequate financial support from private sources and stronger moral support from better informed public opinion.

Paper mill of Maine Seaboard Division of the St. Regis Paper Co. at Bucksport, Me., where continuous bleaching is used

BLEACHING Groundwood-Sulphite Pulp

JAMES A. LEE
Managing Editor, Chemical Engineering

ST. REGIS BLEACHES HIGH-CONSISTENCY MIXTURE OF GROUNDWOOD AND SULPHITE PULP BY CONTINUOUS PEROXIDE PROCESS

For the first time in history a pulp and paper mill is successfully bleaching a high-consistency mixture of groundwood and sulphite by a continuous sodium peroxide process. Use of sodium peroxide as a bleaching and pulping agent is an extremely important development. Its importance has been compared to the introduction of the sulphite and sulphate pulping processes. It has broad applications as a bleach and as an agent in de-inking and reworking old paper.

ONE OF THE pioneers in the use of sodium peroxide bleaching of pulps is the St. Regis Paper Co. Its management early recognized the advantages that might come from the adoption and use of the process developed in the laboratories of the E. I. duPont de Nemours & Co. In June, 1941, it was decided to adopt the operations in the company's Norfolk, N. Y., mill to the sodium peroxide bleaching process. Changes were

made in the mill system which made deckers, tanks, pumps, and other equipment available to the groundwood bleaching process with only minor rearrangements. St. Regis' success with bleaching groundwood by batch methods was described in *Chem. & Met.*, August 1944, pp. 106-108.

New Plant

The marked success in bleaching groundwood in an old and rearranged mill naturally led the progressive management to adopt a program calling for bleaching other types of pulp, at higher consistency,* and by continuous method, also for a new plant especially designed, engineered and equipped for this bleaching process. The relatively new Bucksport mill, Maine Seaboard Division, which had been converted recently from newsprint to book papers, was chosen, and a bleach plant erected and equipped with modern machinery, fabricated from the most efficient materials of construction, at a point where its operations would fit into the straight-line flow of materials through the pulp and paper mill.

CHEMICAL COST ANALYSIS

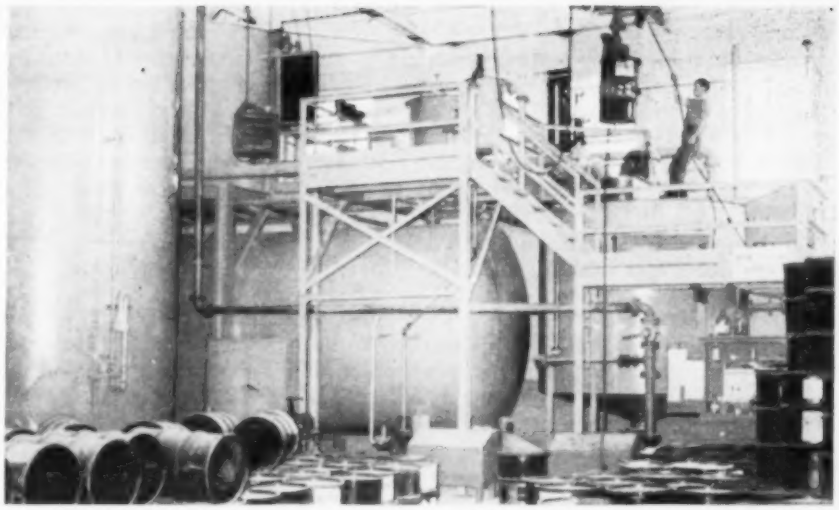
Chemicals	Per Ton of Pulp
Silicate of soda	$0.83
Epsom salts	0.01
Sodium peroxide	4.02
Sulphuric acid	0.14
Sulphur dioxide	1.06
Total	$6.06

Based upon a two-week operating period in which 1,352 tons of a 55 percent groundwood—45 percent sulphite pulp mixture was bleached.

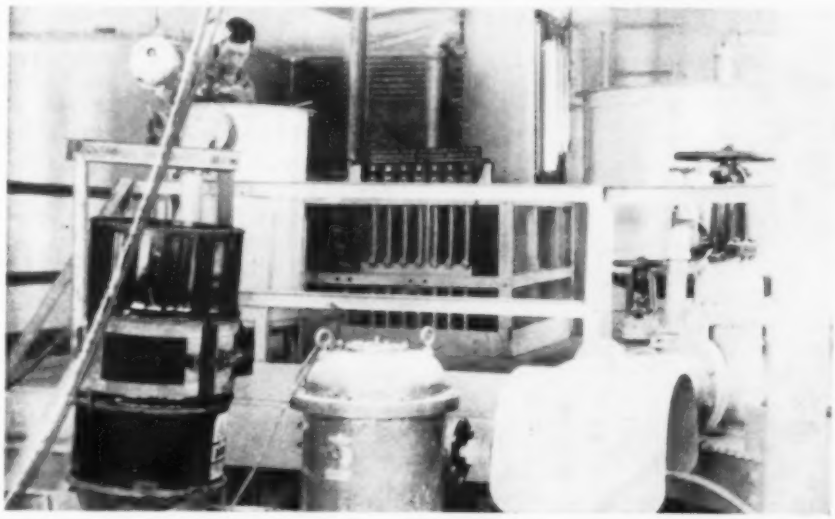
The cost of bleaching a groundwood and sulphite pulp mixture with an average brightness (G.E.)† of 56 points varies with the percent of bleach, consistency of stock, temperature and other factors. At a consistency of about 12 percent and 1.5 percent sodium peroxide the brightness would be increased about 7 points.

Breakdown of Costs

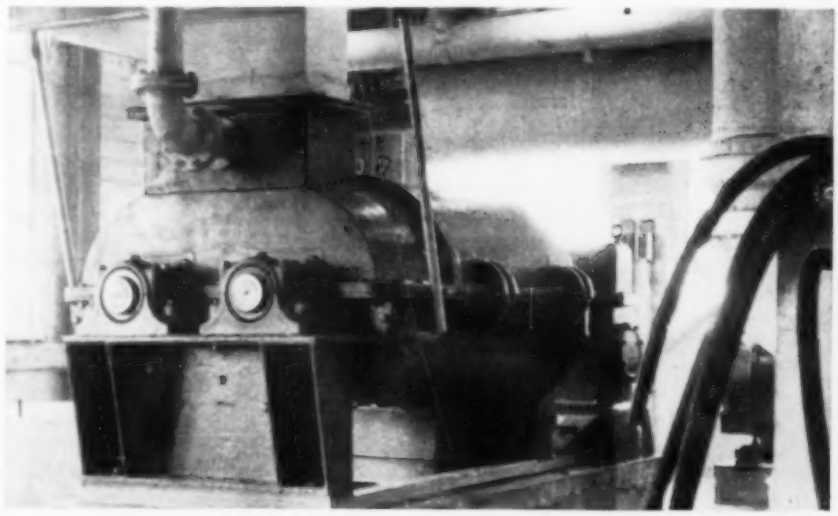
A breakdown of chemical costs, shown in the accompanying table, has been made. It is based upon an operating period of two weeks in which 1,352 tons of a 55 percent



1 Bleach liquor plant. Dissolving tank with man atop is filled with water containing epsom salts. Sodium silicate runs in from large measuring tank on platform at left as operator hoists sodium peroxide drum into position



2 As peroxide feeds slowly into dissolving tank, operator checks next material, sulphuric acid, in measuring tank. Make-up water goes in last



3 Bleaching solution goes to work. Pumped to bleaching plant, solution enters mixer through line at top and starts bleaching the shredded stock

* Consistency is expressed as lb. of moisture-free fiber per 100 lb. of stock, e.g. 5 percent consistency means 5 lb. of moisture-free fiber per 100 lb. of stock.

† Pulp brightness is expressed in terms of units as determined with the General Electric reflection meter (brightness tester).

groundwood—45 percent sulphite pulp mixture was bleached.

The pulp bleaching plant began operations in July of this year. It is the first mill ever to bleach a mixture of groundwood and sulphite pulp in continuous operation. It is streamlined from the wood room to the shipping platform. The process fits in with continuous furnishing of all materials to paper instead of batch furnishing usually employed with beaters, measuring chests or tanks.

Once again pulp and paper, and chemical process industries as a group, are demonstrating the advantages of substituting continuous operation for batch methods with the attendant improved control, more uniform quality of production and higher operating efficiencies. Once more good team work among men on research, process development, engineering design, production and sales, under able management, has resulted in a successful new development.

This continuous process fits into the scheme at Bucksport particularly well for this mill has always been proud of its achievements in straight-line flow of materials and continuous operations.

Advantages

Experience has shown that there are many advantages in the use of sodium peroxide bleaching of pulps. Improvement in brightness is the outstanding result of the bleaching treatment. The brightness increase obtained in bleaching depends on a number of factors, such as color of the unbleached pulp, species and conditions of the wood, and percentage of peroxide used in bleaching. With bleached groundwood, it is possible to include a substantial percentage of groundwood in a paper furnish and still maintain a satisfactory brightness. It is true bleach rather than a chemical for purification such as chlorine. Peroxide not only bleaches but cleans as well. Fiber bundles and dirt specks present in unbleached groundwood are softened and largely disappear in the bleaching treatment. Tanks, pipe lines and other equipment used for handling the bleached pulp are practically free from slime growth, dirt from this source being eliminated.

On the paper machines this pulp handles easily, combining rapid drainage with good forming and "laying" capacity to make possible high machine speeds. The strength characteristics, as measured in pulp, seem to be identical, but due to more uniform sheet formation on the paper machine, it seems to be true that there is a tendency toward a slightly stronger finished paper. The temperature of the pulp is regulated for bleaching so that it maintains more uniform temperature, thus avoiding seasonal changes. This is probably a factor in forming a more satisfactory sheet of paper.

Process

The process consists essentially of the preparation of the bleaching solution, bringing together in the desired proportion the groundwood and sulphite pulps, diluting the stock with white water, thickening the stock on deckers, mixing the bleaching solution with the pulp in controlled quantities, retaining the peroxide-treated pulp long enough to complete the bleaching, reducing and neutralizing the bleached pulp to the desired pH for paper making.

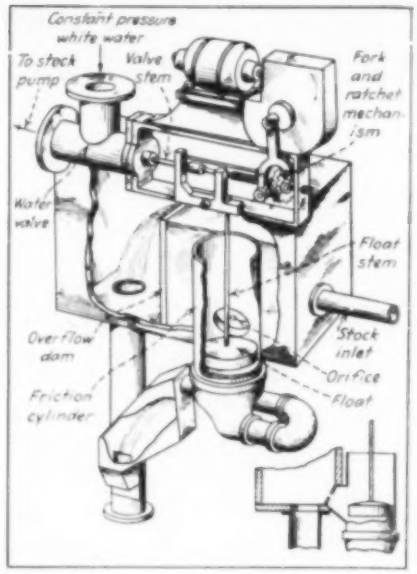
The chemical solutions for bleaching and neutralizing are prepared in a new building near the bleach plant. The bleaching solution consists of sodium peroxide, sodium silicate, sulphuric acid and magnesium sulphate. Sulphur dioxide alone is used for neutralization of the excess alkali.

Sodium peroxide is the active bleaching agent in the process. Although the complex chemical reactions which take place in the bleaching process are not completely understood, the primary reaction is probably a selective oxidation and decolorization of the traces of organic coloring matter naturally present in the wood. The amount of sodium peroxide used in the bleaching process may be varied to produce different degrees of bleaching.

Sodium silicate has the properties of a detergent and a penetrant. It buffers the bleaching solution and aids in maintaining the pH in the desired range. It forms a protective coating on the surface of the metals and inhibits corrosion of equipment. It also has a stabilizing action on peroxide solutions under the conditions which prevail in the pulp bleaching process.

For good bleaching results the total alkali content of the bleaching solution must be controlled within proper limits. Part of the alkali introduced into the bleaching solution by the silicate and peroxide must be neutralized with sulphuric acid.

Magnesium sulphate has a remarkable stabilizing effect on alkaline peroxide solutions under the conditions which prevail in the pulp bleaching process. It performs this function by inhibiting the catalytic effects of the traces of metals, particularly iron, copper and manganese, which are sometimes present in pulpwood and in mill waters.



Trimbey consistency regulator

For the preparation of the bleaching solution a dissolving tank, or mixer, is used. It is equipped with a turbine-type agitator and baffles on the tank to assure thorough agitation during preparation of the solution. It has a bottom outlet. A water supply line of sufficient size to fill the tank in a reasonably short time is also provided.

The dissolving tank is filled about nine-tenths full of water, to which the required quantity of magnesium sulphate is added, and a predetermined amount of sodium silicate is discharged from the calibrated measuring tank into the water with agitation. The required weight of sodium peroxide is then fed slowly into the solution with vigorous agitation. The sulphuric acid is added from a measuring tank with continued agitation. Finally, enough water is added to increase the volume of solution to the required amount. The solution is then pumped to storage tanks and as required pumped from them to the bleaching plant storage tank for use in the process.

The pipe line handling the mixed bleach liquor is rubber-lined steel. The lines handling silicate and 60 deg. Bé. sulphuric acid are plain steel. The line used to transfer bleach solution from storage tanks to bleach plant is stainless steel. The dissolving tank and agitator are stainless steel. The acid, silicate and SO_2 storage tanks are mild steel. La Bour pumps handle acid.

The wood used in the groundwood and sulphite mills is similar. It is mainly spruce and fir in equal volumes with a small amount, perhaps as much

as five percent, of hemlock. When practical the latter is directed toward the sulphite mill. The density of the wood averages about 0.36. There are several sources of wood: (1) the company's own wood lands, mostly spruce; (2) New Brunswick and Nova Scotia spruce and fir; (3) wood from local farmers; and (4) "Island" wood along the Maine coast.

The groundwood is produced on Waterous grinders and is made for book papers. Although a standard plant, the sulphite mill has an interesting new type of acid plant. It has been designed so as to reduce the amount of SO_3 in the SO_2 to a very minimum. A rotary type SO_2 burner and two cooling towers in which the gases are cooled rapidly are used.

Bleach Plant

Groundwood and sulphite pulps at a consistency of 2½ percent are pumped from stock chests in the respective pulp mills to a constant level box in the bleach plant. The flow rate of incoming stock is determined by a Trimbey metering unit and the desired proportion of groundwood to sulphite is also set by this unit. The Trimbey meter is driven by a d. c. motor and the speed of this motor is regulated by a rheostat mounted on the instrument panel board.

A 50/50 ratio of groundwood and sulphite pulps was being used the day the mill was visited. The visit was made in the company of Lyman A. Beeman, vice-president in charge of manufacturing of St. Regis Paper Co., who has been taking an active interest in this development from the beginning, and George Bearce, general manager of the mill. However, a broad range of ratios such as 10 to 60 percent sulphite to 90 to 40 percent groundwood is practical. The proportion of the two pulps depends on the fiber furnish desired to produce the grade of paper being manufactured.

After metering the groundwood and sulphite stocks are brought together in a pipe line, mixed, diluted with white water to approximately 1 percent consistency and pumped to two Impco vacuum thickeners on the top floor of the bleach plant. The height of the stock in the thickeners is held constant by level controllers. It passes over the thickeners and is discharged at 12 percent consistency through a shredder onto a high-speed serrated conveyor which breaks the sheet of stock. This repulper conveyor delivers the stock onto a closed screw conveyor, below the thickeners, known as the heater conveyor. Here the temperature of the stock is raised by live steam from about 70 deg. F. to 91-95 deg. F. The amount of steam consumed will vary over the course of the year. It will also depend upon the relative quantities of groundwood and sulphite employed in the furnish since the temperature of groundwood stock is generally higher than that of sulphite. At certain times during the year it may not be necessary to add any steam.

Steam to the heater conveyor is controlled at the control panel and the rate of flow is recorded. Steam may be added either to the heater conveyor or to the mixer, but it is preferable to use the heater conveyor. If bleaching is carried out at 91-95 deg. F. the subsequent bleaching action is more rapid, and the final color is brighter.

Following the heater conveyor the pulp goes to an Improved Paper Machinery high density bleaching system. The second conveyor discharges the stock through an opening in the floor into the mixer below. The Impco rubber-lined chemical mixer has two revolving, parallel shafts with spikes which intermesh and extend the length of the shafts. Here the bleach liquor from the storage tank is mixed rapidly and uniformly with the stock. The mixing of the chemicals and the pulp is accomplished by kneading and shredding action as the spikes pass each other. Much of the initial bleaching action occurs immediately on contact.

The rate of flow of bleach liquor is governed by percent of bleach desired and by rate of stock flow through the bleach plant. Using 2 percent of peroxide and processing 144 tons of stock per day the flow will be 20 gal. per min. The flow of bleach liquor to the mixer is recorded and the flow rate is controlled manually since the control valve is adjacent to the operator's control panel, and therefore easily adjusted. A rotameter at the control valve indicates the rate of flow of bleach liquor to the mixer.

The addition of bleach liquor to the stock lowers the consistency from 12 to 11 percent. Accurate proportioning and thorough mixing are essential at this stage.

Bleaching Tower

On leaving the mixer the treated stock is discharged by gravity into the opening in the top of the bleach tower, a glazed tile tower, 12 ft. i.d. and 43 ft. high. Passage of the stock through the tower, where the bleaching action is completed, requires from 2½ to 3½ hours depending upon temperature and consistency. While it is in the tower the temperature drops from between 91 and 95 deg. F. to between 86 and 90 deg. F. It is desirable to maintain the level of the stock in the bleaching tower at a uniformly high position.

No agitation is desirable here with the high-consistency system used, as the pulp moves down the tower as a plug until the retention time is complete. At the bottom it is removed by a slowly rotating scraper through variable speed twin screws which serve as a meter to control the rate of discharge. The discharge of this 11 percent consistency stock is facilitated by high pressure white water dilution nozzles near the bottom of the tower. White water is also added at the exit ends of the screw conveyors on the outside of the tower to bring the stock down to about 3½ to 4 percent consistency.

Bleached stock is discharged from the tower by the screw conveyors into the glazed tile bleached stock chest where it is further diluted with white water. This final regulation of consistency is done by a Trimbey regulator equipped with a valve position recorder chart. If the chart shows that too much dilution is being done by the Trimbey regulator (that is, if the consistency is too high in the bleached stock chest), the setting of the hand valves on the dilution controller can be adjusted to increase the flow of primary dilution water.

Trimbey Regulator

This Trimbey consistency regulator consists of a vat with an overflow dam and an orifice, and a friction cylinder controlling the action of a motor-driven water valve. It operates upon the principle that friction changes with consistency and that to maintain a given velocity the head, or pressure, will change as the consistency varies. This automatic change in head is utilized to control the addition, at the suction side of the pump, of the necessary thinning water. A continuous sample of the stock being pumped enters the vat and supplies a constant volume to the friction cylinder through the plate orifice. Friction in the cylinder and in its outlet pipe maintains a constant head as long as the consistency remains uniform, but this head changes decidedly with minute changes in consistency. A float, resting upon the surface of the stock in the friction cylinder, rises and falls with increases and decreases in the head. The stem of this float is linked to a motor-driven fork-and-ratchet mechanism which operates the water valve. When the stock is at the desired consistency the float, riding upon the surface, holds the fork in the neutral position and no

change is made in the opening of the water valve. An increase in consistency causes a rise in the stock level within the cylinder, the float rises, the fork moves into contact to open the water valve, more water is added at the suction side of the pump, is thoroughly mixed with the entire mass of the stock being handled, and the valve continues to open until the stock comes back to normal when the fork again loses contact with the ratchet, leaving the water valve at some new position. A decrease in consistency reverses the operation, the fork engaging the ratchet to close the water valve.

The excess alkali in the stock is neutralized while the stock is in the chest. The sulphur dioxide in liquid form passes through a control valve and into a stream of white water where it is partially absorbed. The flow of sulphur dioxide is automatically governed by a pH recorder. This instrument employs an electrode which determines the pH of the bleached stock leaving the chest. The instrument transmits controlled air pressure to a diaphragm-operated valve in the sulphur dioxide supply line. The sulphur dioxide lowers the pH from 8½-9 to 5-6. While the primary purpose of the sulphur dioxide is to neutralize the alkali, the very fact that the pH is reduced results in a bright color of the stock.

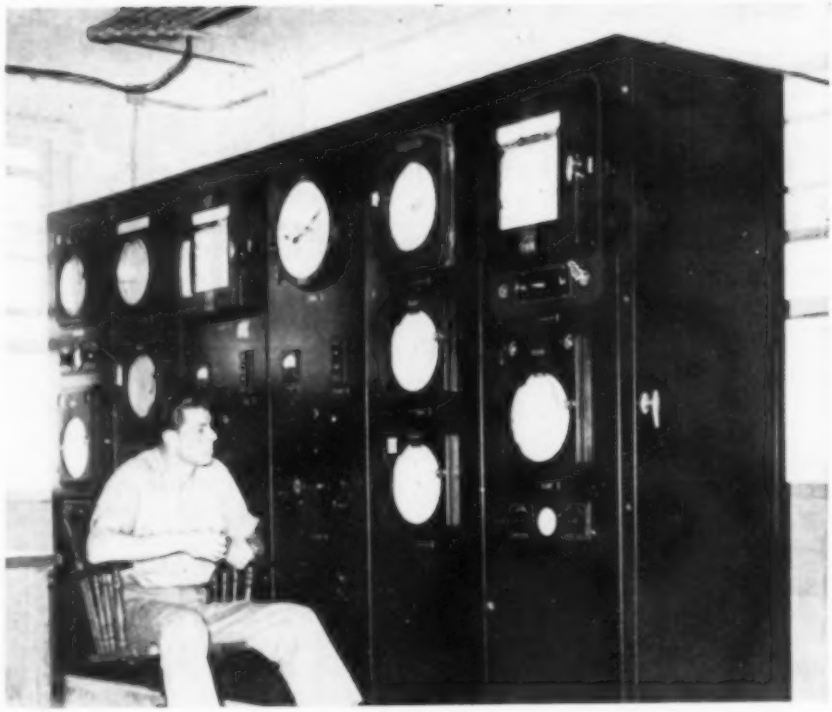
The bleached stock is then pumped direct to the paper machine room.

White Water System

White water from the thickeners on the top floor of the bleach plant goes to a separator of the Nash vacuum pump system which separates air and water. It then goes by gravity to the seal box and from there is distributed to several points in the bleach plant: (1) It may be pumped to the lower part of the bleach tower. (2) Some white water is used for lowering the consistency of the stock in the conveyors at the exit from the bleach tower. (3) White water is used in the final Trimbey consistency regulator before the paper machine. (4) The Ansul valve mixes SO_2 and white water to make H_2SO_3 for use in reducing the pH of the stock. (5) White water from the seal box is also used to reduce the consistency of the groundwood and sulphite pulps after they have been mixed, but before pumping to the thickeners.

The bleach plant is about self-contained as far as white water is concerned since stock comes in and goes out at 2½ percent consistency.

The bleach plant is housed in a new brick-faced steel building of six stories. It has concrete floors and a precast insulated concrete roof covered with tar and gravel. The walls are concrete block, faced with red brick. Unit heaters are used on every floor.



This instrument panel is central control point for entire bleaching plant

Long pipe lines of 7 in. diameter or greater are made of Transite. Otherwise 16 gage stainless steel (316) is used throughout the bleach plant to prevent specks in the final paper which generally result when iron pipe is used. The wooden tanks are Douglas fir, the bleaching tower and bleached stock chest are glazed tile reinforced with iron rods. The deckers are rubber-covered.

The bleach plant operates six days a week, 24 hours a day. The chemical plant, operating 8 hours a day, can prepare sufficient chemical solutions to meet the 24 hour a day requirements of the bleach plant. One man operates the chemical plant and three men operate the bleach plant on each 8-hr. shift plus one additional man in the latter on the daylight shift.

Operation of the bleach plant can best be carried out with the aid of instruments which either control directly or provide a continuous record of a given factor, or at least provide an instantaneous reading. The necessary information is centralized as well as the controls so that the bulk of the bleach plant operation can be carried out by a single operator. Conceivably in time one operator per shift can handle the entire bleach plant.

The instrument control panel, which is the heart of the whole bleaching system, is located on the fifth, or mixing, floor. The two major controls are the amount of incoming stock as metered through the Trimbey metering and proportioning system and the flow rate of the outgoing stock, both being controlled on the panel board by the rheostat adjustments. The panel board also contains the temperature recorders for combined stock from thickeners entering the mixer and at the bleach tower base. The flow recorders show the volume of stock through the Trimbey leaving the bleach tower base and the amount of bleach liquor to the mixer. Flow controllers of steam to the heater conveyor, white water dilution and SO_2 are important. The liquid level recorders for the bleached stock chest and tower are instruments that the operator cannot overlook.

From this panel board sufficient information can best be obtained through use of coordinated controls. The many instruments make it possible to operate the bleach plant with a minimum of guess work.

By means of these control instruments operation of the bleach plant can be coordinated with the fourdrinier machines in the paper mill. When it becomes necessary to stop one or both of the machines a warning signal flashes on the control board in the bleach plant and the operator can immediately stop or slow down operations in the bleach plant.

Calculating Payout Time for Equipment Investments

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IN MAKING economic studies involving the purchase of new plants or equipment, it is frequently found desirable to estimate the so-called "payout period"—the number of years which will elapse before the investment has been completely recovered through savings or added earnings. The usual method of calculating the payout period, which consists in dividing the capital investment by the estimated annual savings (or earnings) to obtain the payout in years, suffers from two serious drawbacks: it neglects the effects of both taxes and interest.

Before the war, taxes were a minor factor for some corporations. Under present conditions, low tax rates are the exception rather than the rule. It is common for a company to pay 40c. for federal and state taxes out of every dollar of earnings. While some reductions in taxes may be anticipated, no substantial relief is in sight for many years. Since taxes will cut earnings almost in half, it is vital that some consideration be given to the effect of taxes in computing payout periods.

Effect of Interest

Although interest rates are now low by former standards, still, the effect of interest in calculations of this type may be significant and should not be entirely ignored. If the capital needed for the construction of a new plant must be raised by issuing bonds calling for an annual payment of interest, it is obvious that this interest represents a charge against the earnings of the plant. If no bonds are issued, and the cash needed is drawn from the fluid capital of the company, interest is still involved since the money taken to build the plant could otherwise have been used, to earn a return by investment, or in retirement of existing debt.

The effect of both taxes and interest can be included in a payout calculation by means of a stepwise calculation which will determine, for each year, the net amount of capital recovered. This computation must be continued, by years, until the entire investment is shown as recovered. Such a method is apt to be both laborious and time-consuming. The following formula, which achieves the same purpose, was developed to eliminate the use of the lengthy stepwise method:

$$n = \frac{\log Z - \log (Z - Ii)}{\log X - \log Y} \qquad (1)$$

Here $X = 1 + i/2$; $Y = 1 - i/2$; $Z = S(1-t) + tD$; I = capital investment in new facilities; S = net annual savings, before taxes and interest charged, made possible by new facilities; i = effective rate of interest; t = tax rate applicable to earnings; and D = depreciation allowed for tax purposes.

If the equipment to be installed will replace existing equipment, S will be the net annual savings made possible by the new equipment. If the plant under consideration is entirely new, S will represent the net annual earnings of the plant before taxes and interest.

The term i represents the *effective* rate of interest, i.e., the actual out-of-pocket interest cost after allowing for the effect on taxes. Since interest is chargeable against income and thus reduces the taxes paid, the true interest cost will be less than the apparent interest. For example, assume that bonds have been issued to acquire capital for the new investment, bearing interest at 4 percent. With a tax rate on earnings of 40 percent, each dollar paid in interest will reduce earnings by $1 and will therefore reduce taxes by 40c. The apparent cost of interest is $1, but the true cost amounts to only 60c. Then $i = 0.04(1-0.40) = 0.024$. The *effective* rate of interest is therefore 2.4 percent.

The term t represents the tax rate applicable to earnings and is the sum of the federal and state tax rates.

Depreciation is not normally included with expenses in calculating a payout. However, depreciation is an allowable deduction in computing taxes. To cover the effect on taxes alone, a factor for depreciation has been included in the formula. Depreciation allowed for tax purposes may be different than depreciation charged on the books of the company, or depreciation based on estimated years of life. This item, therefore, should properly be estimated by the tax department of the company.

Both S and t are assumed to remain constant for the entire payout period. If this period is expected to be long, and considerable changes in the values of these two items are in prospect, there is no alternative but to carry out a stepwise, year by year calculation.

When using Formula (1), it is advisable to use five-place logarithms, because there is a loss of several significant figures when taking the difference between the two terms of the numerator and denominator, which are almost equal in value.

Simplified Formula

Formula (1) is usable only when i is greater than zero. If it is desired to neglect interest, the following simple formula should be used:

$$n = I/Z \qquad (2)$$

It is simpler but gives full effect to the important factor of taxes. It may be used if the interest rate is low and the payout period relatively short.

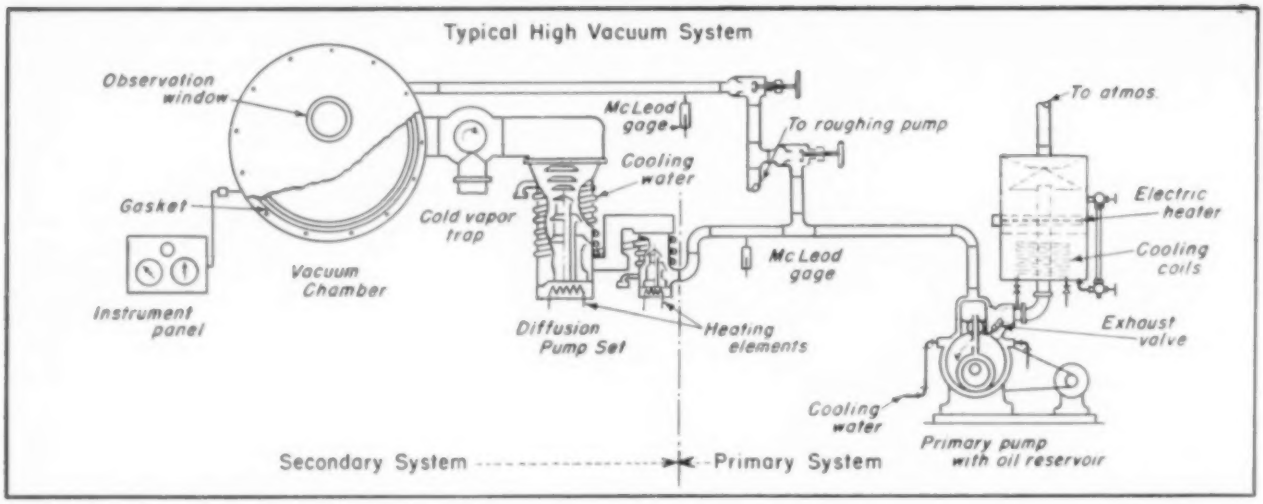
Example 1—A piece of labor-saving equipment costing $500,000 is estimated to give gross annual savings in reduced labor costs (over existing equipment) of $250,000. However, power consumption and maintenance will be increased by $50,000 per year. A bank loan at 4 percent interest will be necessary, while federal and state tax rates for the company total 40 percent. A depreciation of $25,000 per year will be allowed for tax purposes.

Here $I = 500{,}000$; $S = 250{,}000 - 50{,}000 = 200{,}000$; $i = 0.04(1-0.40) = 0.024$; $t = 0.40$; and $D = 25{,}000$. Hence, $X = 1 + 0.024/2 = 1.012$; $Y = 1 - 0.024/2 = 0.988$; $Z = 200{,}000(1-0.40) + 0.40(25{,}000) = 130{,}000$; and $Z - Ii = 130{,}000 - (500{,}000)\ 0.024 = 118{,}000$. Taking logarithms of the last four quantities, and substiting in Formula (1),

$$n = \frac{5.11394 - 5.07188}{0.00518 - (9.99476 - 10)} = 4.04$$

The capital will be recovered in four years.

Example 2—Using the same data and neglecting interest, the shorter formula gives $n = 500{,}000/130{,}000 = 3.85$. The capital will be recovered in slightly less than four years, a difference in the results with the two formulas that is not significant.



1 Extremely low pressures are needed in many new chemical processes. Systems like this make high vacuum possible

High Vacuum and Its

USE OF HIGH VACUUM IS FAST BECOMING A STANDARD CONSIDERATION IN PREPARING NEW APPROACHES TO TROUBLESOME SEPARATION PROBLEMS

Large scale production of penicillin, molecular distillation, food dehydration, and improved metal refining are landmarks in the development of high vacuum techniques for the process industries. This article explains how these high vacuums are obtained and shows where they are applied effectively in operations.

ENGINEERS and physicists applying their efforts in decreasing time required to evacuate vacuum chambers and to obtain lower pressures on a large scale have made possible the introduction of many new products and have accelerated the production of others.

Prior to 1941, pumping speeds as great as 100 liters per sec. at pressures then attainable were considered exceptional. Today, a modern four-stage oil diffusion pump with a two-stage booster pump will handle more than 20,000 liters per second and attain pressures in the neighborhood of 0.005 micron (5×10^{-6} mm.) of Hg.

Meaning of Terms

Use of the arbitrarily selected terms, low or partial vacuum, medium vacuum and high vacuum may apply to pressures from atmospheric down to 100 microns of Hg, from below 100 microns to 1 micron and below 1 micron, respectively. These divisions of pressure are governed largely by the behavior of the flowing gases within the above pressure ranges; for example, from atmospheric pressure down to 100 microns of Hg the flow is said to be viscous because of the tendency of the gaseous molecules to adhere to the interior pipe surface. The conductance C of the piping system may be obtained from the formula $C=0.243 \frac{D^4}{L} p$. The term conductance refers to the volume of gas expressed in liters a second that will flow through a length L of pipe or ducts at a given pressure p. The volume flow F of gas in liters per second may be obtained by substituting the inlet and outlet pressure (p_1-p_2) in place of p; that is, $0.243 \frac{D^4}{L} (p_1-p_2)$. Between 100 microns and 1 micron the flow may be classified as laminar because the gas appears to flow in fairly well defined layers. When calculating laminar flow the formula is modified by combining it with a formula for molecular flow and a third formula to correct for the gas flow characteristics in this transition range, that is:

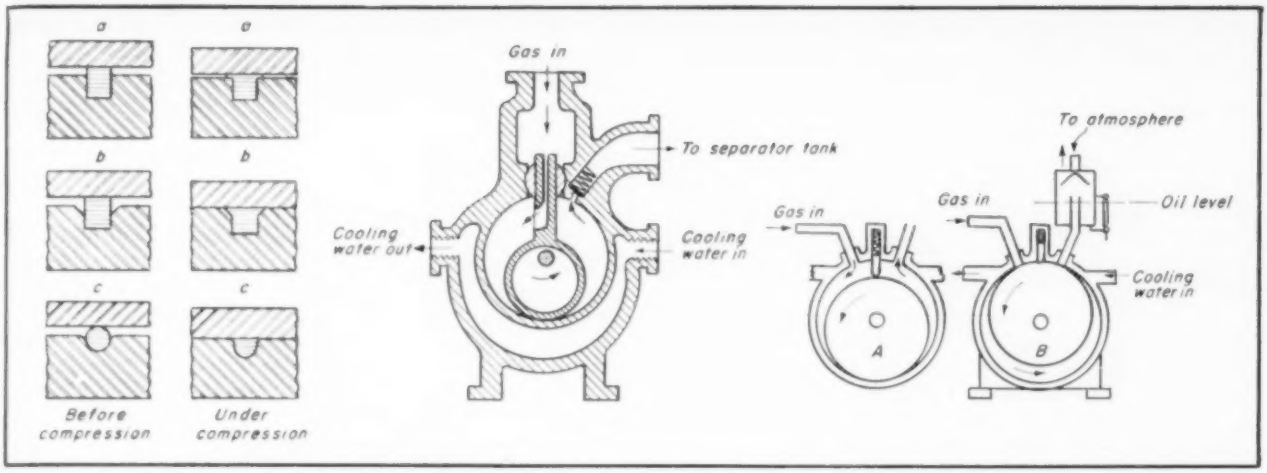
$$C=0.243 \frac{D^4}{L} p + 6.8 \frac{D^3}{L} \times \frac{1 \times 0.62\, Dp}{1 \times 0.72\, Dp}$$

At pressures below 1 micron the flow may be referred to as molecular. Here the pressure within the system is so low that it becomes a negligible factor in flow calculations, and in the molecular flow formula the term p is disregarded, or:

$$C=6.8 \frac{D^3}{L}$$

Here D is in inches; L in feet; p in microns of Hg abs.; 0.243 is a constant derived from 8 × viscosity of air; and 6.8 a constant derived from Knudsen's formula.

As lower and lower pressures are realized, the problem of determining the pressures attained is recognized.



2 Correct gasket fit is essential. B and C show how this is obtained

3 Here is one of the types of mechanical rotary pump used in primary systems

4 This shows a vacuum pump, at *A*, at bottom and, at *B*, at top of its cycle

Process Applications

B. W. WHITEHURST

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Research and engineering improved the cold cathode type of ion gage known as the Phillips ion gage. A modern alternating current gage of this type will give reliable pressure indications between 5×10^{-4} and 5×10^{-6} mm. Hg abs. The lower pressure values do not represent the gage's limit of readable indications, but the pressure observations may be obtained without estimating.

Leakage of atmospheric air into a vacuum system, and the leakage of fluids from coils within the vacuum chamber constitute the main sources of trouble in attaining low pressures. The soap and water under-pressure method of leak detection used by early research workers is far removed from the modern electronic leak detector which, when used with an exploring gas such as helium, will detect one part of helium in 100,000 parts of air within the system.

In adapting extremely low pressures of the order of 10^{-7} mm. Hg to process applications, certain fundamental pieces of equipment are required. These are shown in Fig. 1. Each piece of equipment must be designed and sized so that the combined parts of the system function as an efficient unit capable of obtaining and maintaining consistently the degree of vacuum necessary to properly process a specific material.

Shape of Chamber

The vacuum chamber may be of any shape. Because of its inherent resistance to collapse due to external pressure, a sphere is theoretically most desirable. However, in practice, a vacuum chamber of cylindrical shape is often used, the length being suited to the requirements of the equipment in the interior of the chamber and the material to be processed. A chamber of this shape possesses resistance against collapse and is adaptable to a variety of industrial uses. The degree of ellipticity of the chamber affects greatly the ability of the wall to resist collapse. Generally for steel the ratio between the outside diameter D of the chamber, in inches, and the thickness t of the wall, in inches, should not be over 30, that is $D/t<30$. If the chamber is made of copper, brass or other metals of lower tensile strength the wall must be correspondingly thicker. Where square or rectangular shapes are used, means to prevent excessive inward deflection of the side walls must be provided.

In cases requiring low temperatures, coils are provided within the vacuum chamber for the circulation of a refrigerant. Circulating hot water may also be used to raise the temperature of the material being processed to increase the rate and degree of dehydration or release of vapors and gases. This type of piping is usually of small diameter and commercial thicknesses of piping of tubing usually suffice.

Metallurgically high temperatures are provided within the chamber when refining such metals as magnesium, beryllium, potassium and calcium. High melting point metals and alloys may be melted, by means of high frequency induction, in a vacuum and refined or melted down. The resulting products are substantially free of air, are dense and such impurities as oxides are absent.

Gaskets to prevent the passage of atmospheric air into the vacuum chamber are obtainable in rectangular, flat or round cross sections. These are usually inserted in retaining grooves in the flange surface between the door or cover of the vacuum chamber which is bolted or clamped to the chamber

wall, also between piping flanges. Where oil is not encountered, natural rubber gaskets, because of their elasticity, are superior to the synthetics. Synthetic rubber gaskets are oilproof and if a tensile strength of 2,000 psi., and a maximum compression set of 12 percent are specified, they are satisfactory. Natural and synthetic rubber gaskets have fairly high outgassing values. Over compression and pinching of gaskets must be avoided. To provide satisfactory exclusion of atmospheric air, round or rectangular gaskets should be inserted in correctly sized retaining grooves having chamfered edges to prevent cutting of the gasket. An incorrectly designed groove and gasket is indicated at *A* in Fig. 2. Correctly designed grooves for square and round gaskets are shown in *B* and *C*. In the former the gasket overlaps the groove and may be severely cut by the sharp edges of the groove, and the desirable metal to metal contact of the closure surfaces is prevented. In *B* and *C* the gaskets while under compression completely fill the grooves.

Instruments

Instruments of the mechanical and electronic indicating and recording type are installed at suitable observation points, often a remote distance from the vacuum chamber to inform the operator of the degree of vacuum attained and to acquaint him with the progress of the reaction. Sensitive electronic leak detectors capable of determining qualitatively test gases are used to indicate the leakage of atmospheric air into the system.

Cold vapor traps are necessary to remove condensable vapors from the gas stream, thus reducing the time required by the pumps to obtain the desired low pressure. Generally the trap is filled with a low boiling point liquid such as liquid air or nitrogen or solid carbon dioxide immersed in a low volatile contact liquid. In any case the evaporation of the coolant reduces the temperature of the trap's surface below the freezing point of the vapor to be removed from the gases. In processes where relatively large quantities of water vapor are present, such as in dehydrating food products and blood plasma, a trap of the rotary type is preferable. In such traps an inner cylinder containing the coolant rotates and the water vapor freezes on the rotor's external surface. A knife set at an oblique angle shaves the ice from the rotor, thus presenting a continuously ice free surface to any incoming vapors.

Another vapor trap suitable when the volume of moisture to be condensed is relatively small is the stationary tube.

Vacuum pumps are classified according to the functions they perform. The expression, primary pumps, may be interpreted to mean pumps discharging directly to atmosphere, whereas the outlet of a secondary pump is connected to the inlet of a primary pump. The two pumps performing in series as a unit attain lower pressures than would be obtainable with a primary pump alone. The diffusion pump is a good example of a secondary pump. (*Editor's Note: See Chem. & Met.*, October 1943, page 105.)

Secondary Pumps

High vacuum work would not be practical without the diffusion pump, whose fundamental purpose is to produce a vacuum lower than that which can be created by mechanical pumps. It consists essentially of a glass or metal pump barrel, a series of circular nozzles and a source of external heat for vaporizing a pumping fluid usually mercury or oil. In the upper section of this barrel is usually located a system of baffles designed to prevent backward migration of oil into the vacuum chamber being exhausted. Cooling water flows through coils attached to the external surface of the barrel to provide a cool internal surface on which the oil vapors will condense. The lower section of the barrel is referred to as the boiler.

The internal parts of the pump consist of a series of concentric cylinders on which are mounted flat collars discharging outward and downward. These annular openings are arranged one above the other. In a three-stage pump the upper nozzle is referred to as the low-pressure stage; the middle nozzle as the intermediate stage and the lower one as the high-pressure stage. The lower stage nozzle determines the discharge pressure against which the pump will operate. This may also be interpreted as the degree of vacuum or forepressure the primary pump must create before the secondary pump will begin to function. The higher the allowable forepressure the more flexible is pump operation.

A diffusion pump set usually consists of a main pump of fairly large proportions, and a smaller booster pump. While either pump may function independently, the difference in their operating range is marked. Their combined advantages are best realized when they are operated in series and as a unit.

In operation the oil is vaporized in the boiler compartments and the released vapors are directed upwards by the chimneys and through the nozzles obliquely downward toward the condensing surface of the barrel. The downward travel of the oil vapor carries along gas molecules that drift into the vapor stream from the space above the upper or low pressure nozzle to the space below the lower or high-pressure nozzle. The gas molecules then flow from the pump barrel by the pressure difference created by the primary pump. The oil, after streaming down the inside of the pump barrel, re-enters the boiler compartment and is recycled continuously. These conditions are repeated in the booster pump.

Assuming that enough oil is being vaporized, the speed of the pump is a function of the aperture area and the design of the upper nozzle. Over rather wide limits the temperature of the oil or the rate of heating has no marked effect on the pump's performance. The characteristics of an oil, however, may influence to a great extent the degree the vacuum attained. The distillation curve of the oil within the operating temperature range should be reasonably flat. Generally, the higher the boiling point and the molecular weight of the pump oil, the lower will be the ultimate pressure.

Small size diffusion pumps are obtainable in metal or glass, in single or multi-stage units. Small glass pumps require a power input of 60 to 250 watts and attain pumping speeds from 4 to 25 liters per second at pressures from 1×10^{-6} mm. to 5×10^{-7} mm. Hg without the aid of a vapor cold trap. With a cold trap the ultimate pressure may reach 1×10^{-9} mm. or lower. Small metal pumps require 85 to 375 watts and attain speeds from 2 to 100 liters per second at pressures 1×10^{-6} mm. or lower.

Large Size Pumps

Large size oil diffusion pumps are usually constructed of metal in units comprising a secondary pump of two or more stages directly connected to a two-stage booster pump. When backed by a primary pump capable of producing a forepressure of 150 microns (0.15 mm.) or lower, a four-stage pump with a two-stage booster will exhaust 20,000 liters per second at a pressure of 0.005 micron (0.000005 mm.) or lower.

Mercury diffusion pumps are also excellent secondary pumps and attain pressures comparable with oil diffusion pumps. However, size for size, the oil pump surpasses the mercury pump in volume of gases handled per second at the lower pressures. It must be recog-

nized that mercury vapors are toxic, and are more difficult to condense, thereby demanding relatively larger cold trap condensing surfaces than would be required for oil vapors.

Mechanical pumps, particularly the oil seal sliding vane, rotary type, when connected in series and aided by a liquid nitrogen trap, will attain pressures as low as 0.01 micron. However, at this pressure the gas handling capacity is relatively small compared to diffusion pumps.

Primary pumps are usually mechanical and of the rotary type. Because of their simplicity and ease of operation they are preferred for primary service by many engineers. In one type the rotor, mounted eccentrically in relation to the barrel, causes a hollow vane to reciprocate in a slot in which it is mounted. The movement of the rotor and the sliding vane draws into the cylinder a quantity of gas which is compressed and exhausted from the pump (Fig. 3).

Large size single oil sealed rotary pumps will handle up to 100 liters per second at pressures as low as 10 microns Hg (0.01 mm.), the capacity depending on the type of pump.

Another type of mechanical pump has a single vane which moves in a radial slot in the body of the pump by the rotation of an eccentric cylinder. The inlet and exhaust ports are located close to the vane on alternate sides depending on the size and use. These pumps will exhaust up to 10 liters per second at pressures as low as 0.1 micron (Fig. 4). With a liquid air trap in the vessel being evacuated, a pressure of 0.05 micron is consistently obtainable. These pumps are widely used in medical, biological, and electronic research and in many industries. The type of primary pump selected must provide a sufficient margin of pressure below the upper operating forepressure cutoff point of the diffusion pump and must have sufficient capacity at the operating pressure of the secondary pump to handle the volume of gases evacuated.

Oil Reservoir

Nearly all rotary pumps have an oil reservoir, mounted on the exhaust side, which serves to provide lubrication and oil sealing to the moving parts and provides a means of separating by steam or electric heat the water condensed from the exhaust gases. Cooling coils are provided to remove the heat from the oil.

Vacuum piping systems must have tight joints, preferably welded, to prevent the leakage of atmospheric air into the system. The piping must be correctly sized to reduce to a minimum the resistance to gas flow. In calculating the area of the piping and ducts, consideration must be given to the nature of gaseous flow at the operating pressure. For example, if the system is to operate at pressures below 1 micron Hg the piping and equipment should be sized for molecular flow, whereas if pressures below 100 microns and above 1 micron are to be utilized laminar flow formulas should be used.

Some of the common causes of leaks are welds and seams improperly made or subsequently opened by expansion and contraction; deterioration or improper installation of gaskets; corrosion of equipment; and improper sealing of valve stems.

High Vacuum Applications

The typical vacuum system described above and shown in Fig. 1 may be adapted to many industrial applications. Each application may require modifications such as the type and size of the pumps and the design of the vacuum chamber, and the type of cold trap required to remove the released vapors. Some of the products made possible by the adaptation of high vacuum to industry are described below.

Blood Plasma—The exigencies of war gave impetus to the processing of human blood plasma. Large quantities were prepared by strictly hygienic methods that included rapid dehydration in order that the bacterial growth might be controlled and deterioration of the essential elements of the plasma prevented.

The first step is the removal of the red corpuscles from the yellowish plasma. After this has been accomplished, the plasma is then quickly bottled and frozen. It is then placed on water jacketed shelves within the vacuum chamber, and the pressure reduced rapidly to approximately 0.5 mm. Hg. Warm water is next circulated through the water jackets to melt the frozen plasma and speed the escape of moisture. The released moisture may be condensed on a rotary cold trap containing dry ice.

Adequate pumping capacity must be provided to prevent the pressure within the chamber from rising to a value that would unduly prolong the processing time. Either mechanical pumps or multi-stage ejectors are satisfactory for use in evacuating the chambers. Where steam is abundant, steam ejectors offer the advantages of ease of operation and low maintenance.

Penicillin—Production of penicillin at a price low enough to permit widespread use would have been impossible if ultra low pressures were not available. Moreover, Army hospitals were urgently calling for tremendous quantities of the anhydrous product which required extremely low pressures for quantity production.

Dehydration of penicillin is one of the most difficult of all desiccation procedures because this substance parts with its water reluctantly and although it has the appearance and feel of a dry substance, it may still contain enough moisture to cause deterioration.

Globules of penicillin removed from the mold cultures are dropped into bottles and frozen. These bottles are then placed on suitable racks for dehydrating. With the aid of diffusion pumps and cold traps 99.95 percent of the original water content is removed.

Dehydrating Foods—Citrus juices have been dehydrated and reduced to a crystalline bulk approximately 1/50,000 of their original volume and weight. One pound of orange juice crystals dissolved in water and charged with a small quantity of CO_2, yields 6,250 gal. of orange juice that can not be distinguished by taste from fresh fruit. Only a small fraction of the original content of vitamin C is lost.

Fruits, vegetables, meats, fish, eggs and other foods are dehydrated by freezing the product to preserve it and then evaporating the moisture at ultra low pressures.

Molecular Fractionation

Molecular Distillation—Ultra low pressures make possible the molecular fractionation of complex organic compounds, many of which can not be separated at atmospheric pressure because the temperatures at which the substances vaporize are higher than the temperatures at which they decompose. The number and activity of the air molecules at the surface of the liquid causes the volatile molecules to rebound into the liquid. At ultra low pressures the blanket of air above the boiling liquid is removed, thus increasing the mean free path of molecules after leaving the liquid surface. As a result, a greater number of such molecules escape from the hot surface and arrive at a relatively cold one placed directly above the evaporating surface where they impinge and condense before they collide with others and are deflected into the boiling liquid.

Molecular distillation is utilized for separating vitamins, particularly A and E, from fish liver and other vitamin bearing oils; for the fractionation and

identification of organic compounds, and for investigating the structure of the material in question.

Metal Refining—Among the metals which are difficult to handle and process by conventional methods but which may be produced and refined at low pressures are sodium, calcium, antimony, beryllium, potassium, and magnesium. The vacuum removes most of the gases which could combine with the metal being refined, thereby yielding a product containing a minimum of contaminants. Pressures employed in plants on a commercial scale for this purpose average 5 microns Hg.

Electronics—The successful operation of electronic devices depends upon effective electron flow in high vacuum. Some of the practical uses of electronics are in radio and television receivers, X-ray tubes, and photo electric cells. In some of these applications pressures below 0.001 micron Hg are required.

Elements whose molecular weights and other physical characteristics differ so slightly that they defy separation by conventional means may be separated successfully by electronic separation within a magnetic field.

The manufacture in a high vacuum by electronic bombardment of radio-active products such as C^{14} and activated phosphorus has been accomplished in many of our universities. The half-life of such radio-active materials, unlike radium, is relatively short. Thus minor quantities of these materials may be used therapeutically without harmful effects.

Impregnating Equipment—By subjecting electric cables to pressures as low as 0.01 mm., the air from the smallest bubble can be withdrawn from the insulation and the space formerly occupied by air refilled with an insulating compound, thus increasing the effectiveness and life of the cable.

Electrical capacitors (condensers) are also subjected to low pressures and materials such as bitumen, paraffin, and other higher dielectrics, heated sufficiently to render them fluid, are then used to replace the air between the successive wrappers of the capacitors.

Optical Surfaces—Lenses, flats, prisms, and other optical units are placed within a vacuum chamber and the pressure reduced to 0.05 micron (5×10^{-5} mm. Hg) and magnesium fluoride previously placed within the chamber is vaporized. Due to the absence of air the fluoride molecules bombard the optical surfaces with considerable force forming a hard bluish coating approximately 0.000006 in. thick which decreases surface reflection sufficiently to increase total light transmission as much as 8 percent.

SO_2 Control Problem Solved In Sea Water Bromine Plants

PORTER HART

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ONE of the most difficult problems involved in the commercial extraction of bromine from sea water is the control of the SO_2 mixed with the bromine-laden air. To understand how engineers of the Dow Chemical Co. solved this problem, first at the original Wilmington, N. C., plant and later at the newer Freeport, Tex., plant, it is best to examine briefly the essentials of the bromine extraction process itself before considering the control of the SO_2.

Essentially the process consists of (1) acidifying sea water and oxidizing it with chlorine to liberate free bromine, (2) blowing the free bromine out of solution with air, (3) mixing the bromine-laden air with SO_2, (4) passing it through absorbing towers with water to form hydrobromic acid and sulphuric acid solution, and (5) chlorinating this hydrobromic acid to free the bromine, which is driven off with steam and collected in the liquid form.

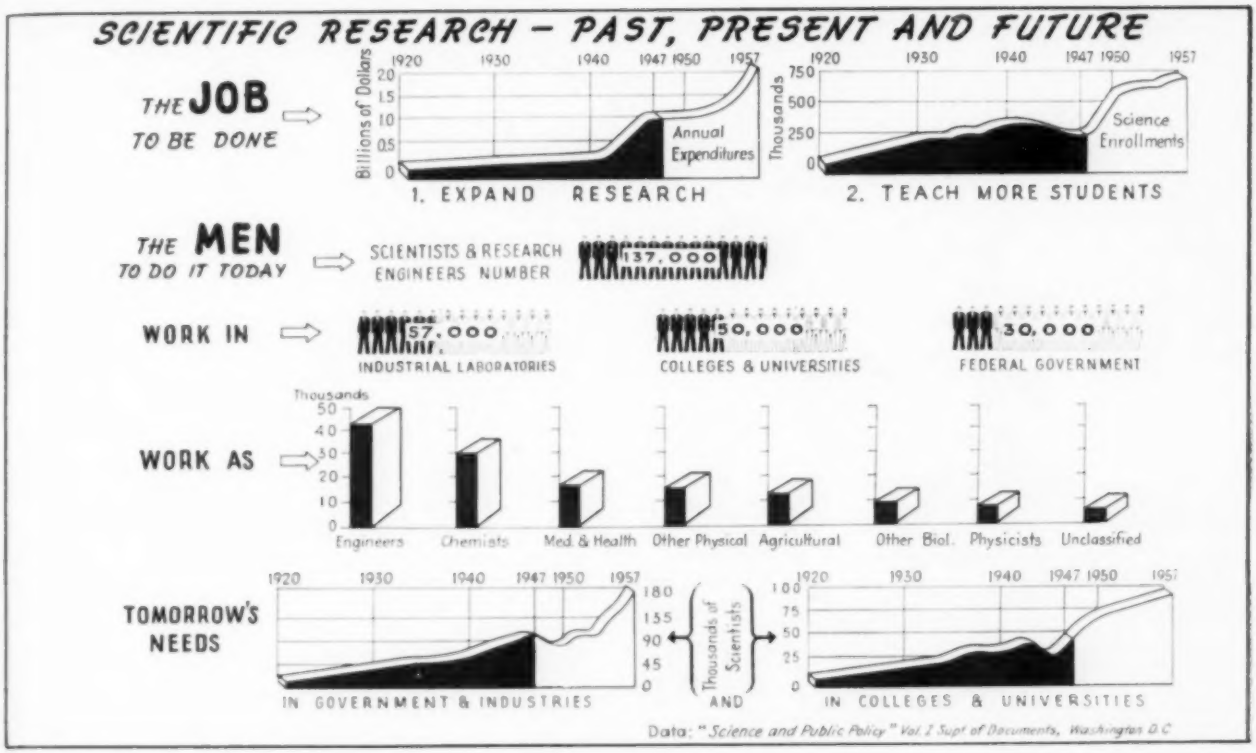
The extraction of bromine from sea water takes place in a blowing out tower in which a current of air removes the bromine from acidified and oxidized sea water. The bromine-laden air from the tower is mixed with SO_2 in a duct system connected with a water absorption system collecting the hydrobromic acid and sulphuric acid. In order to obtain satisfactory controls on this system it was necessary to devise methods for holding constant the strength of the acid and SO_2 and also to control chlorine pressure, so that in reality the only things that would affect control changes would be the sea water salinity, the rate of pumping and atmospheric conditions.

To solve the ticklish SO_2 control problem, a sample of the mixed gases passing into the absorption tower was drawn through a blower to the electrode sampling system and returned to the tower. Also, a controlled amount of bromine-laden air was drawn directly from the blowing out tower and mixed by the sampling blower to titrate continuously the excess SO_2 in the mixed gases. This was done to raise the oxidation potential for maximum sensitivity of the electrode assembly.

The final design of the electrode system was quite simple. The titrated gases were blown down through a small glass column and returned to the absorber. In the glass column hung a solid center rod pointed on the bottom end. A slightly acid solution passed down over about 10 in. of the glass rod, dropping off the pointed end at a rate of approximately one to two drops per second onto the measuring system. This measuring system consisted of a platinum electrode and saturated calomel half cell reference electrode. This proved very successful because it had very little inventory effect. The platinum electrode and reference cell hold only the drop which is between them. It is pushed off by the next drop. The film on the rod comes to a saturated equilibrium with the mixed gas very rapidly. It was necessary to hold all conditions possible very stable because this complete control system had a 20 sec. velocity-distance lag. The range of the recording potentiometer controller is 0-1,000 millivolts. This controller operates a 16 in. air damper on the suction side of the sulphur dioxide blower which draws SO_2 from a sulphur burner. The titration of the mixed gases with the bromine-laden air is regulated so that normally the electrode system is on the halogen side between 600 and 700 millivolts. For properly adjusting this system a gas sample is drawn from the stack to the control laboratory and titrated periodically with a photoelectric titrating device using iodine-starch solution.

The mixture of SO_2 and bromine-laden air when properly controlled should contain a very slight excess of SO_2 so that after passing through the absorber there would be no bromine and a very minimum amount of SO_2 exhausted to the atmosphere. At times this control was operated with such precision that the exhaust stacks were completely neutral.

Excerpt from a paper presented before the second national conference of the Instrument Society of America, Chicago, Ill., Sept. 8-12, 1947.



Plans for Nation's Scientific Future

THE STEELMAN REPORT OF THE PRESIDENT'S SCIENTIFIC RESEARCH BOARD MAKES SEVEN MAJOR RECOMMENDATIONS

1. Expand research, train more men—Let 1 percent of the national income be the minimum budget for research and development in the physical and biological sciences including medicine. Gradually increased spending will accomplish this by 1957. The government's role: finance at least half the national budget ($1 billion by 1957), but not necessarily do the work in its own laboratories. Today, with money available, the limiting resource is trained man power. Schools and the government feel the shortage most—especially schools, which need 15,000 instructors. Recognize the importance of industrial research by amended corporation laws.

2. More medical and basic research—Our present program is unbalanced in the direction of military and applied research. In the next ten years, quadruple expenditures for basic research; triple those for health and medical research; double those for the total program. Bulk of basic research expansion must come in the universities and colleges financed by Federal funds. To support basic research outside its own laboratories, the Federal government should: Spend $50 million in 1949 and $250 million by 1957; legislate to permit outright grants instead of contracts when the government finances Federal work to be done outside; allow all departments to obligate research money five years ahead to ensure a stable program.

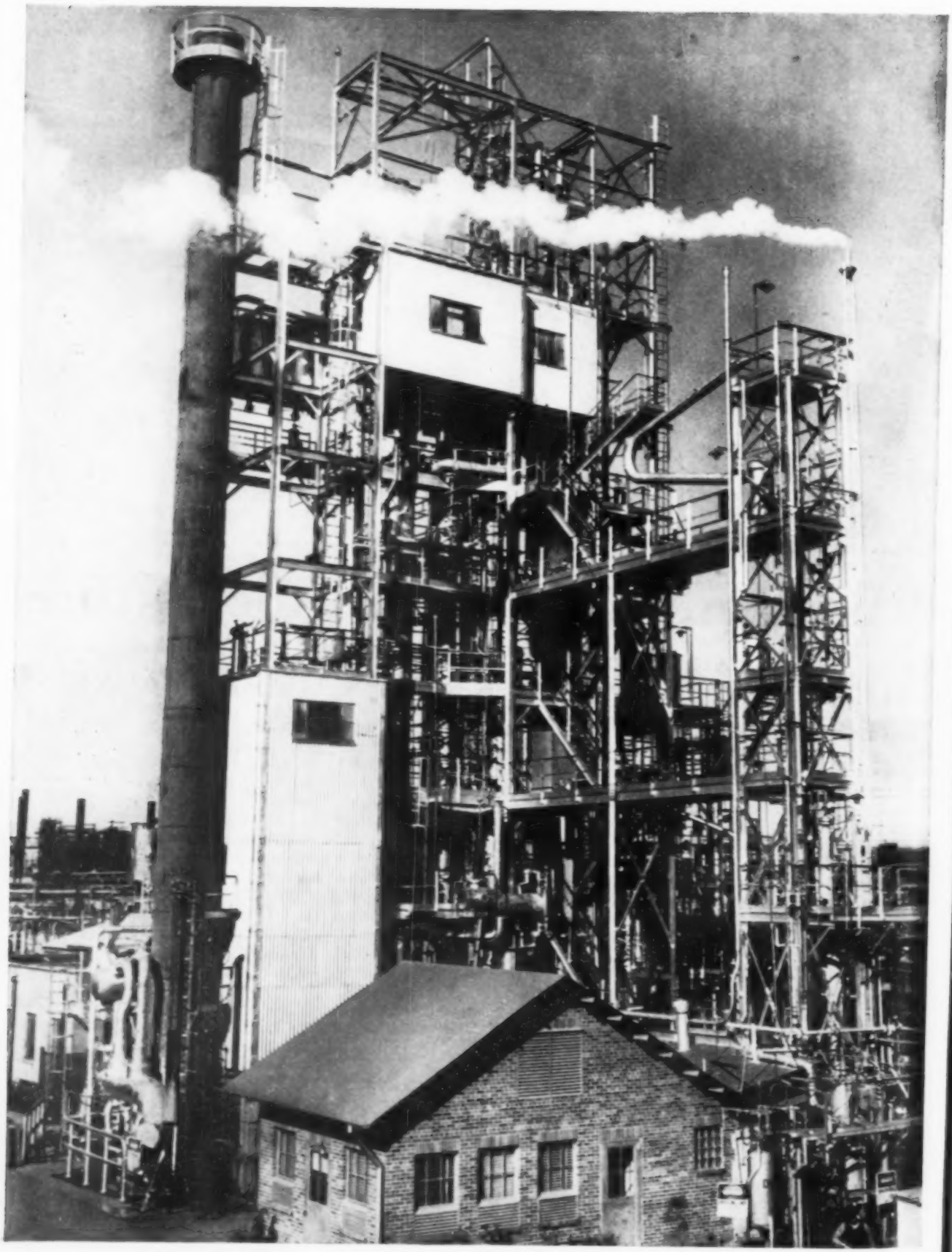
3. Establish a Science Foundation—General plan: Created by Congress; its director appointed by and responsible to the President; a part-time advisory board of scientists and educators—half from the Federal government, half from outside. Let it concentrate on financing fundamental research in universities; also, help strengthen weaker, but promising, schools.

4. Establish a research committee—General plan: Composed of government officials most deeply concerned with research and development and others with a direct interest in such matters. To coordinate Federal scientific programs; set general policies, prevent overlapping projects; maintain the balance between fields of research. For immediate action: Reports on (1) the relative advantages of contracts and grants, (2) advantages and problems of establishing research coordinating bodies in large Federal agencies, (3) means of improving accounting procedures for research and development activities throughout the government.

5. Aid students—No later than 1950, establish a comprehensive program of assistance to undergraduates and graduates. The U. S. Office of Education or its successor would administer a program applicable to all fields of learning, not just physical and biological sciences.

6. Aid schools—As an integral part of a broader program of aid to higher education, give Federal assistance to universities and colleges for laboratory facilities and scientific equipment.

7. Aid Europe—In the rehabilitation program of the Marshall Plan, include provision for re-establishing scientific research in Europe on a basis of free international exchange of information. Stimulate the international flow of students and research workers. Establish scientific missions abroad. Make foreign contributions, especially Russian, more accessible by arrangements for translation and distribution.



MODIFIED FISCHER-TROPSCH process, using fluid catalyst technique, is employed to synthesize gasoline, diesel oil and oxygenated compounds from natural gas in this Standard Oil Development Co. pilot plant at Baton Rouge, La.

Esso's Fluid Catalyst Modifies Fischer-Tropsch

JAMES A. LEE
Managing Editor, Chemical Engineering

NATURAL GAS BECOMES SOURCE OF LIQUID FUELS AND MANY CHEMICALS THROUGH USE OF FLUID CATALYST IN FISCHER-TROPSCH PROCESS

CONVERSION of natural gas and coal into such liquid fuels as gasoline and diesel oil has loomed largely in the current research and development programs of the petroleum refining industry. No fear of a future oil shortage, as some persons may think, has brought this development. It has come because of the hard economic facts that the cost of locating and producing oil has increased and that the demand for petroleum products has stepped up enormously.

A leader in this movement is Standard Oil Development Co., research affiliate of Standard Oil Co. (N.J.). This company, together with the Pittsburgh Consolidation Coal Co., has been studying coal carbonization in a pilot plant located at the Disco plant of the latter company near Pittsburgh. Engineering and design studies are under way for another pilot plant to study complete gasification of coal. This pilot plant, to be built at Library, Pa., near Pittsburgh, will be completed in early 1948. Of more immediate importance are the eight pilot plants Standard Oil Development Co. has now in operation. In these plants hydrocarbons are synthesized from natural gas by fluid catalyst techniques. It is with three of these pilot plants, located at the Baton Rouge, La., refinery of the Standard Oil Co. of New Jersey, that this article will principally deal.

In Germany Franz Fischer and Hans Tropsch announced in 1926 their new process for synthesizing gasoline and diesel oil from coal. The German process got into commercial operation in 1933 at Oberhausen in the Ruhr. The process consists of two stages. The first stage is identical with that used in gas works to make ordinary manufactured gas from coal. In the second stage this manufactured gas becomes the raw material, or synthesis gas, which is catalyzed into gasoline and other synthetic products.

Types of Reactors

Two types of reactors, both relatively small, were designed by the Germans for use in the second, or synthesis, step itself. The first reactor, for use at atmospheric pressure, consisted of a box with several horizontal boiler tubes within it; the other, for use at 100 lb. per sq. in., consisted of a cylindrical vessel in a vertical position, equipped with a double pipe system between tube sheets. The stationary, preformed cobalt catalyst was used in pelleted or granular form, lying between the tubes.

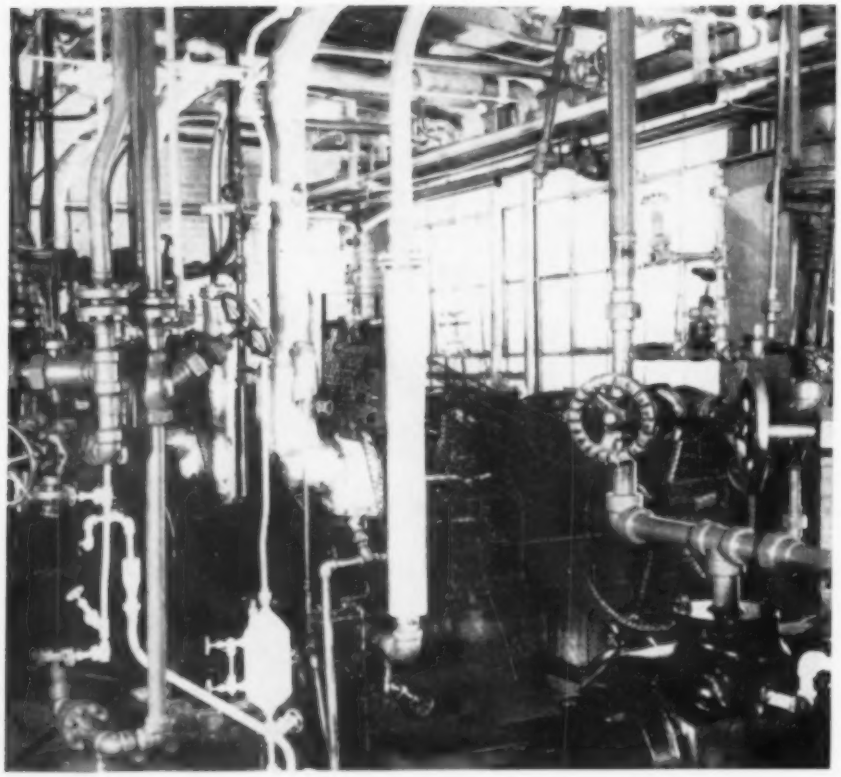
To remove the enormous amount of heat evolved, a plant capable of producing 10,000 bbl. per day of synthetic gasoline required 128 reactors with a cooling surface of about 5,800,000 sq. ft.

Obviously, the investment cost for a commercial plant in Germany was very high, approximately $8,000 per bbl. of products produced per day. Too poor in quality for use as aviation fuel, the gasoline produced by the Fischer-Tropsch process was also a low quality motor fuel as judged by present American standards. The other products, except the diesel fraction, were used principally to synthesize chemicals.

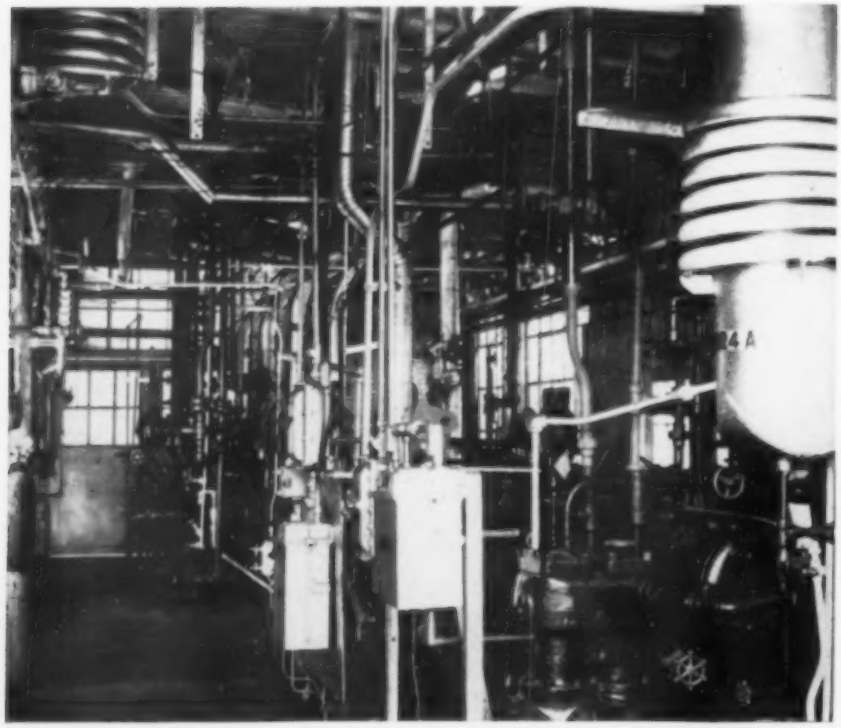
Challenged by such shortcomings of the German process as its multiplicity of reactors, with attendant high heat transfer area, and its poor quality gasoline and other synthesis products, American chemists and engineers of the Standard Oil Development Co. swung into action. To reduce the number of reactors and thus the cooling surface, they sought to replace the stationary catalyst with one in fluidized form. To improve the quality of the gasoline and other products, they began a search for a catalyst of better composition than the cobalt one of Fischer and Tropsch.

The use of three fluid catalyst pilot plants on natural gas, two small and one large, at Baton Rouge, permits the Esso Laboratories simultaneous investigation of such different phases of the problem as examination of different

Certain modifications that are being made in the Fischer-Tropsch process by Standard Oil Co. (N.J.) will have a tremendous effect on the petroleum refining and chemical industries. It will be possible to produce gasoline and diesel oil from natural gas at values competitive with production from petroleum and simultaneously to produce large volumes of valuable chemicals.



Compressors are used for compressing synthesis gas and recycling gas in the modified Fischer-Tropsch process. Synthesis gas is a mixture of carbon monoxide and hydrogen. It is converted into liquid fuels and chemicals



Another view of compressor room at large pilot plant at Baton Rouge where fluid catalyst has been substituted for Germans' stationary catalyst. Use of the fluid catalyst to convey heat to all parts of the reactor has been an outstanding advance in making this process commercially interesting

catalysts and study of different operating conditions. The smaller units are useful for obtaining process data. The large one has a normal capacity of 5-10 bbl. of synthetic products per day, depending upon the size of reactor employed and the operating conditions. These conditions are varied widely because the engineers seek design data from this plant. In this large unit utmost flexibility is provided. It is very highly instrumented, far more than would be necessary or even desirable in a commercial plant. Results obtained in small and large plants are in good agreement.

Since natural gas is of primary interest in use of this process in the United States, it was chosen as raw material in the production of synthesis gas at the Baton Rouge pilot plants. The Germans had used coal or coke.

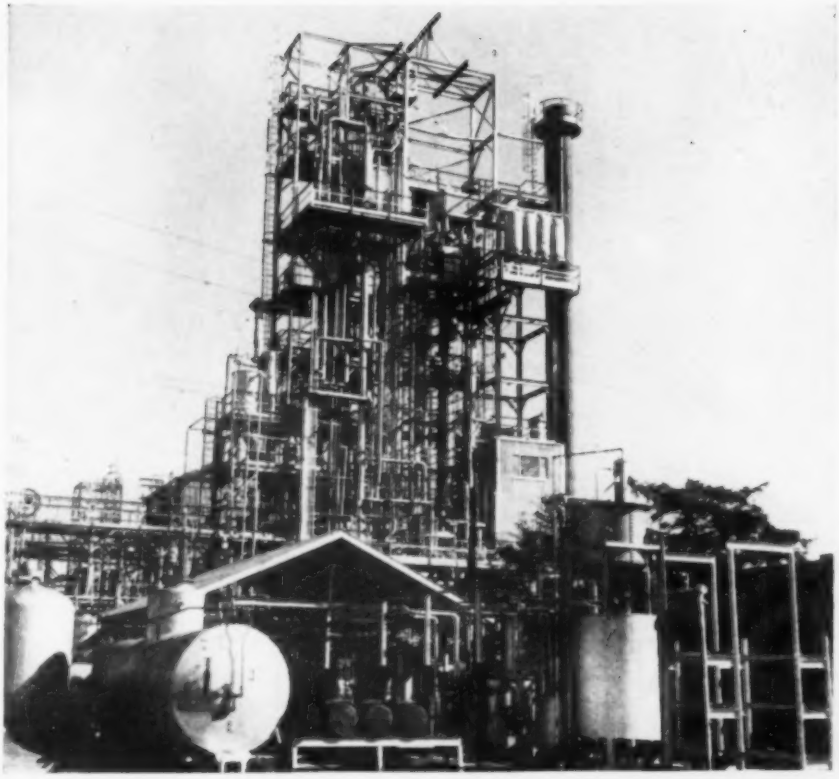
The natural gas is mixed with steam and carbon dioxide in a tubular reformer furnace at about 10 lb. pressure and at 1,500 deg. F. or more. The equipment, similar to that now used for production of hydrogen from natural gas, employs high-alloy tubes suspended in a furnace. In the furnace reformation takes place, forming carbon monoxide and hydrogen, together with a small volume of carbon dioxide. The reacting gases pass downward through beds of catalyst contained in the tubes and to a heat exchanger where they are cooled. The gases next pass through a tower in which the carbon dioxide is removed, leaving the synthesis gas.

Although the above method is used in the Baton Rouge pilot plants, the Standard Oil Development Co. plans to use partial oxidation of natural gas to generate synthesis gas in plants of commercial size. This will be carried out in a combustion-type vessel by burning the methane with pure oxygen at a pressure slightly above synthesis pressure and at a temperature of approximately 2,500 deg. F.

Concentrated upon the second stage of the process, the conversion of the synthesis gas, a mixture of carbon monoxide and hydrogen, into gasoline and other products, research and development at Baton Rouge have licked the major shortcomings of the older German process and cut costs. Its fluid catalyst, similar in principle to that used in catalytic cracking, has been substituted by the Standard Oil Development Co. for the stationary pellet catalyst of the Germans. Thus the number of reactors required in a plant producing 10,000 bbl. a day of synthetic gasoline has been reduced to six, or one-twentieth the number required by the German fixed-bed de-

sign. The cooling surface has been slashed from nearly 6,000,000 sq. ft. in the original Fischer-Tropsch process to 35,000 sq. ft., less than ½ of one percent of that needed in the German plant. This, of course, means a large reduction in plant investment, maintenance and operating costs.

The use of fluid catalyst in the American modification of the Fischer-Tropsch process has been one of the outstanding advances in making this process commercially interesting to Americans for conversion of gas or coal into liquid fuels. There have been advances, too, in the types of catalysts used. Catalysts employed by the Germans gave very paraffinic products, and the gasoline obtained was low in octane number. The catalyst mainly considered for application in this country is of a different type and gives mostly olefinic materials, and the gasoline made is of relatively high octane number. Furthermore, improvement in performance of iron catalyst has resulted in the development of material considerably cheaper than the German cobalt catalyst, while new, cheaper iron catalyst produces more gasoline of higher quality over its useful life. In addition, this material simultaneously produces quantities of valuable chemicals.



Pilot plant makes 5-10 bbl. per day of synthetic products. Synthesis gas generator is in corrugated building at right. Tanks are for product storage

Powdered Catalyst

In the Standard Oil Development Co. process, the finely powdered catalyst, maintained in a fluidized condition, lies in a deep, dense mass, filling the space around the cooling tubes and the reactors. The synthesis gas is forced in at the bottom of each reactor, and the synthesis reaction begins at once to generate a violent heat, the fluid catalyst conveying the heat to all parts of the reactor. A cooling surface is provided in the fluidized bed to remove the high heat of reaction which amounts to 1.7 million B.t.u. per bbl. of liquid products. Although the number of water tubes in the newer process has been reduced enormously, the tubes still function efficiently as a boiler to produce steam for power purposes throughout the entire plant. The maintenance of an even catalyst temperature despite this large heat evolution has been a major obstacle to low cost production.

In their pass through the mass of iron catalyst, the carbon monoxide and hydrogen of the synthesis gas are re-aligned into a range of hydrocarbons varying in molecular complexity. The primary products are obtained from the mixture of gases and vapors which passes out of the top of the reactor.

The hydrocarbons and water that are produced are condensed from the vapor stream. Residual gas is partly recycled to the reactor. The light hydrocarbons are recovered. Residual tail gas can be used for heat or power requirements, used to make more synthesis gas, or sold as fuel. To recover entrained catalyst and return it to the reactors, both filters and cyclone separators have been used at the large pilot plant, but cyclone separators will probably be specified when designing a plant of commercial size. Fractionating and recovery equipment for the separation, recovery and finishing of the hydrocarbon products of the synthesis is for the most part conventional.

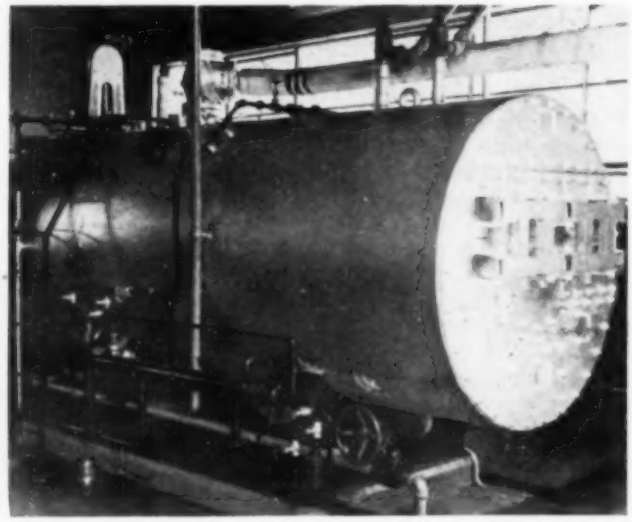
The reaction results principally in gasoline which, after mild treatment, has an ASTM unleaded octane number of about 80 and a research unleaded number of about 93, some diesel fuel, alcohols and acids. The amount and distribution of oxygenated material as compared to liquid hydrocarbons depends upon the operating conditions. The oxygenated compounds are largely lower alcohols, methyl through amyl, and the lower fatty acids, acetic through butyric. Also some acetaldehyde and acetone are found. The oxygenated materials are mostly a diluted mixture in water.

Result of the investigations in the three pilot plants at Baton Rouge thus far has been a satisfactory demonstration of use of the fluid catalyst technique. It is an excellent tool for securing uniform temperatures and high rates of heat transfer. Conversion and yield have been good.

It has been estimated that a hydrocarbon synthesis plant, large enough to produce 8,300 bbl. per day of gasoline giving an ASTM unleaded octane number of about 80 after mild treatment and 1,050 bbl. per day of gas oil, based on the use of the fluid catalyst, would cost about $35,000,000, exclusive of the investment for recovery of oxygenated compounds. If the price of natural gas is assumed to be five cents for 1,000 cu. ft. and the oxygenated compounds are credited at estimated future market realizations, the cost of gasoline comes out at a value competitive with its production from petroleum today.

Production of liquid products from natural gas, using a modified Fischer-Tropsch operation, appears, as officials of the Standard Oil Co. (N.J.) have pointed out, reasonably attractive from an economic standpoint at the present time. Any increase in oil prices will make the production of oil products from natural gas more attractive. There is, however, a higher investment involved in the production from natural gas.

1 Thirty billion units of penicillin per month are produced by Squibb in its new Mexico City plant



2 Steam for cleaning, sterilizing and process heating is provided by this automatic oil-fired boiler

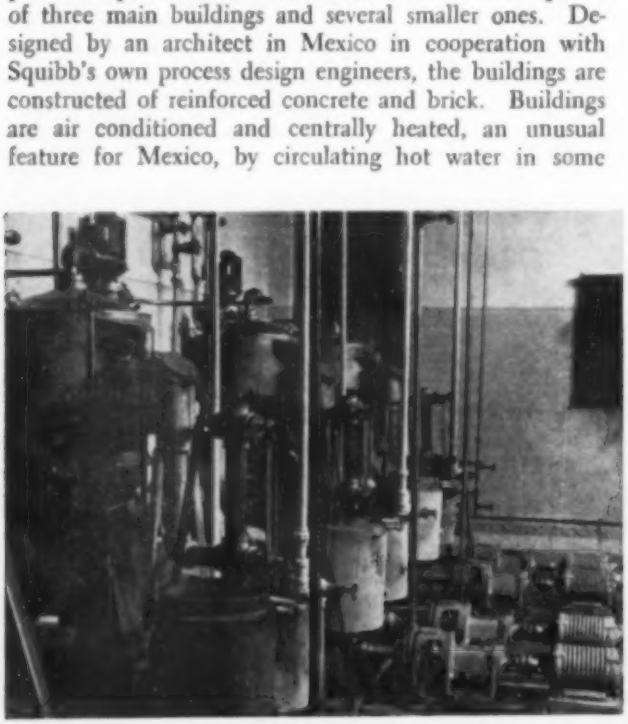
New Penicillin Plant Now

CULMINATING several years of planning and construction, a new pharmaceutical plant in Mexico was recently placed in operation by E. R. Squibb & Sons Co. First planned in 1944, this new $300,000 plant is modern in every respect and contains complete facilities for manufacturing penicillin and a number of other medicinal products previously imported.

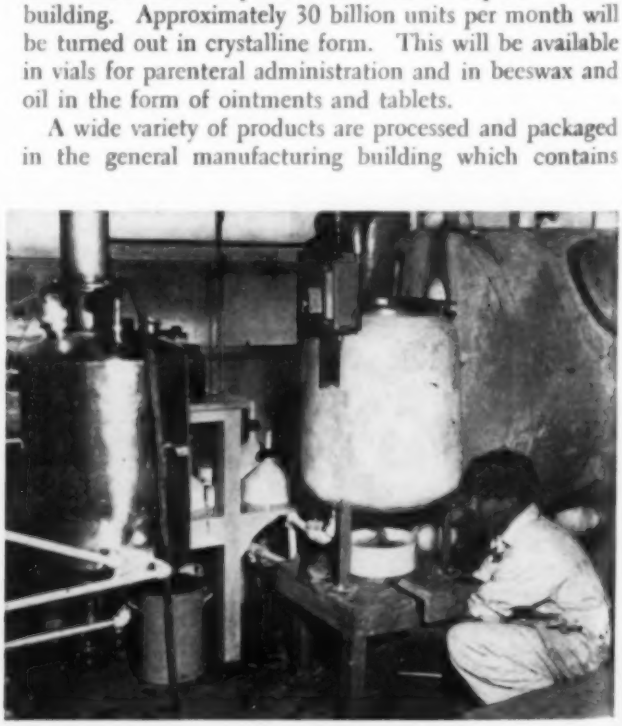
Located in San Angel, a suburb of Mexico City, the plant occupies an area of about 4½ acres and is comprised of three main buildings and several smaller ones. Designed by an architect in Mexico in cooperation with Squibb's own process design engineers, the buildings are constructed of reinforced concrete and brick. Buildings are air conditioned and centrally heated, an unusual feature for Mexico, by circulating hot water in some areas and low pressure steam in others. For the most part, process and packaging equipment is American made.

Penicillin manufacture takes place in a 2½-story building containing nearly 11,000 sq. ft. of floor space. Large storage and blending tanks are two stories high and, like most of the process equipment are installed on the first floor. Here also is storage space for both raw materials and finished products. The packaging department and control laboratory are situated on the top floor of the building. Approximately 30 billion units per month will be turned out in crystalline form. This will be available in vials for parenteral administration and in beeswax and oil in the form of ointments and tablets.

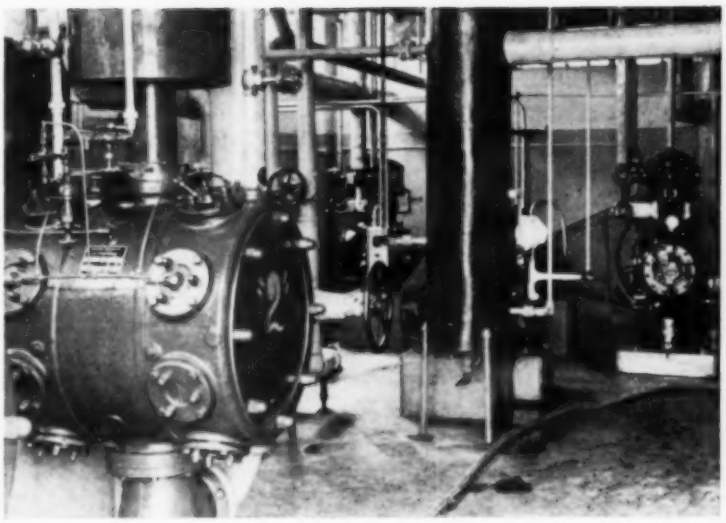
A wide variety of products are processed and packaged in the general manufacturing building which contains



5 Penicillin broth is further purified by use of solvents in these centrifugal separators



6 The stainless evaporator on the left is used to crystallize penicillin from the purified concentrate



3 Most of the process equipment including compressors and refrigeration units was imported from the U. S.

4 Insoluble waste material is separated from penicillin broth in rotary filters

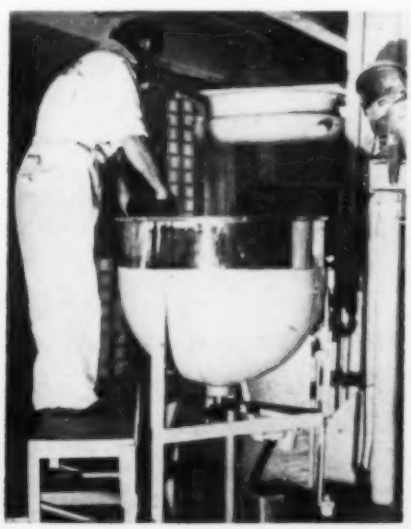
Operating in Mexico

over 30,000 ft. of floor space. This two-story structure is built in the form of a U. Raw materials are stored on the top floor where all processing operations take place. Finished products pass by gravity to the lower floor where they are packaged under sterile conditions. Except for penicillin, all products are manufactured in this building. Approximately 60 percent of the 125 Squibb products currently on the market in Mexico are completely manufactured here. About 20 percent will continue to be imported from the Squibb plants in the United States in bulk shipments, and sub-divided and packaged at this plant. Another 20 percent will continue to be imported in the completely finished form. The principal product, however, to be made completely in this new plant is penicillin. A number of other products that are manufactured here include dental cream and powder, vitamin tablets, all types of sulfa drugs, and a variety of other preparations.

The administration building houses executive offices, accounting and sales departments, the medical director and the director of special services, together with their staffs, control and development laboratories, and an extensive medical library.

Squibb's Mexican operations employ approximately 250 people, of which 155 are required for manufacturing operations. For some time the Mexican market has been large enough to warrant the opening of such a plant as this. It is now expected that this country will receive much better service in regard to obtaining pharmaceutical products than ever before.

7 Rubber stoppered vials of penicillin are compressed in tablet machines



8 Ointments are formulated and processed in steam jacketed kettles

9 Pills of different sizes and kinds are compressed in tablet machines

Process Engineer's Guide to the Centrifugal Compressor—I

IGOR J. KARASSIK

Application Engineer, Worthington Pump & Machinery Corp., Harrison, N. J.

TERMINOLOGY, BASIC IDEAS, SIMILARITY TO CENTRIFUGAL PUMPS, AND FIELDS OF APPLICATION, ARE DEALT WITH IN THIS ARTICLE

In the last decade there has been a growing trend toward the application of centrifugal compressors. The next ten years promises not only to consolidate their gains in various industries but also to extend their use considerably further. It may be stated freely that the growing application of centrifugal compressors is paralleling very exactly the history of centrifugal pumps, beginning some 30 or 40 years ago.

Why the Trend

To the question whence came this trend and interest in centrifugal compressors, we may say that they originate from three separate but mutually reinforcing causes. First, there has been a marked increase in the scope of a number of industrial operations and processes which require the handling and compression of various gases, an increase which brought the volumes of gases to be handled well beyond the range where reciprocating machinery could be applied economically and into a range fully suited for centrifugal compressors. Second, there has been and is taking place, a tremendous development of new industries—mainly in the petroleum and chemical fields, but also in others—which frequently necessitate the handling of gases in large volumes. Finally, developments and improvements in the design of centrifugal compressors have lowered minimum capacities for their economical utilization, into a range of applications which was formerly met with reciprocating machinery only.

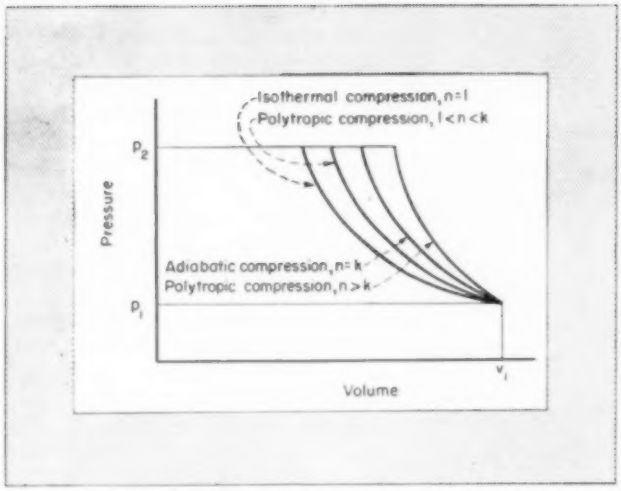
The foregoing should not be interpreted to mean that the centrifugal compressor will supplant the reciprocating compressor in all applications. Instead, we may expect to see a repetition of the evolution which took place in the parallel field of pumping machinery. Where 40 years ago centrifugal pump applications were rare and generally limited to very large volumes and very low heads, the range of application has grown at a tremendous pace until today it covers the majority of possible conditions of service. At the same time, however, the reciprocating pump continues to fulfill its useful function in the range of low volumes and high pressures.

Because of the later introduction of centrifugal compressors into many fields of use, and because of the extremely rapid growth of these uses in recent years, the subject of centrifugal compressor application has remained somewhat mysterious to its potential users. This situation is further aggravated by the fact that the science of compression machinery is somewhat more complex than that of pumping equipment. Also, in the early stages, there was an evident tendency to explain the operation of centrifugal compressors through analogy to reciprocating machines. Nothing could be more conducive to confusion than such an attempt.

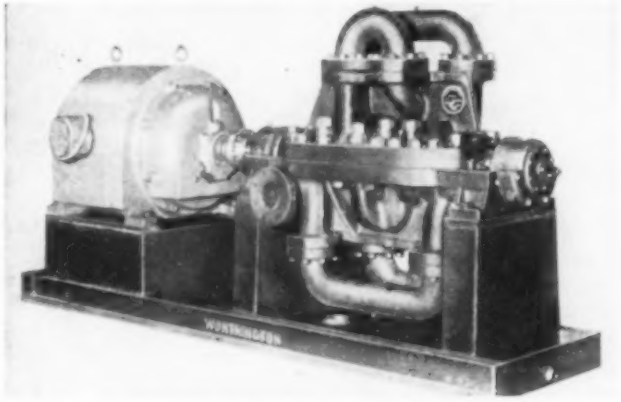
For Process Engineers

The series of which this article is the first was undertaken with the intention of presenting a clear conception of the centrifugal compressor from the point of view of theory and design practice. Another aim is to introduce certain technical data necessary in the computation of centrifugal compressor application problems, in a form more useful than those commonly employed. The author is constrained to apologize at this point for the fact that these articles cannot be made devoid of a certain number of formulas and mathematical relations of a varied degree of complexity. This apology arises mainly from the author's general reluctance to complicate a subject any more than is absolutely necessary. At the same time, introduction of a certain amount of theory is un-

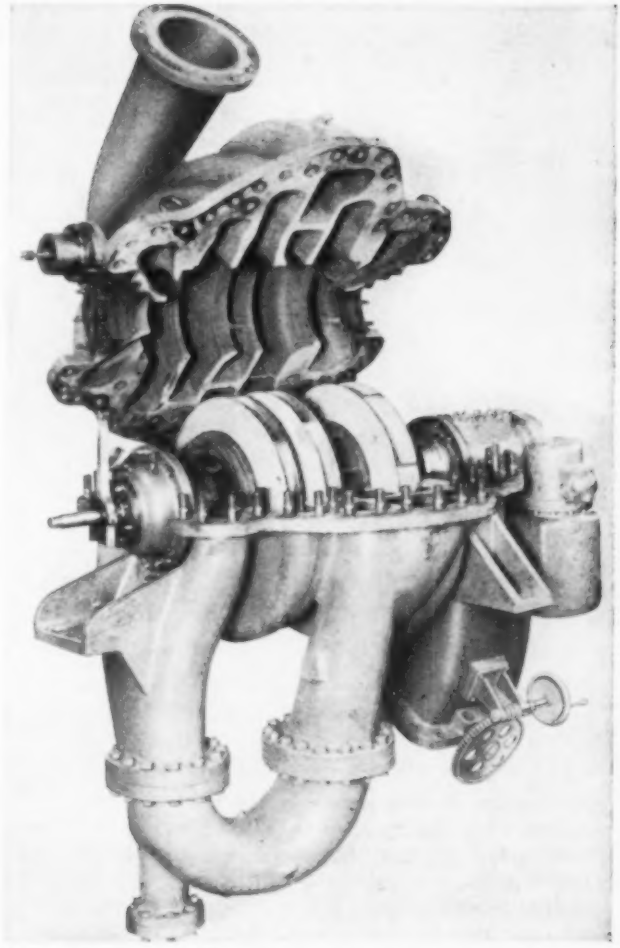
For various reasons centrifugal compressors have tended to be something of a mystery in the eyes of the average engineer. Now that their field is expanding rapidly it is important that the mystery be dispelled, a task that Mr. Karassik undertakes in this and a series of articles to follow. Addressing himself to the compressor user rather than the designer, the author includes everything necessary for a thorough "application" understanding.



1 Pressure-volume diagram of polytropic compressions



2 Six-stage centrifugal boiler water feed pump



3 Three-stage centrifugal compressor for Freon

avoidable, owing to the nature of the problem. It may be added, however, that the solution of mathematical relations so far as possible will be presented in chart form and that a relative minimum of calculations will be required to solve any application problem.

Definition of Terms

Although it will be seen later that centrifugal compressors are quite similar to centrifugal pumps, it is obvious that in addition to certain hydraulic terms familiar to engineers who have dealt with centrifugal pumps, there is a great deal of thermodynamic terminology which must be understood before one can be familiar with centrifugal compressors. No attempt will be made here to present a complete text book review of thermodynamic principles, as the reader can easily obtain this additional background from a number of excellent works on the subject. Instead, a series of definitions of terms commonly used in compressor work will be presented below, while a short review of those relations of thermodynamics which will prove useful in following the calculations will be presented later.

Absolute Pressure is the total pressure measured from absolute zero. It is, therefore, the sum of the gage pressure reading and of the atmospheric pressure corresponding to the barometer reading. It is generally expressed in pounds per square inch.

Absolute Temperature is the temperature measured from absolute zero. When expressed in degrees Fahrenheit, absolute zero corresponds to −459.6 deg. F. The absolute temperature, then, corresponds to the sum of the temperature reading in degrees Fahrenheit, plus 459.6. For simplicity of calculations, the round figure of 460 deg. F. is generally used.

Perfect Gas Law expresses the equation of state for gases and specifies that

$$144\,p\,v = R\,T$$

where p is the absolute pressure in pounds per square inch; v is the specific volume in cubic feet per pound; R is a constant which depends on the nature of the gas; and T is the absolute temperature in degrees Fahrenheit.

Specific Heat is the amount of heat required to raise the temperature of a pound of gas 1 deg. F. The specific heat of a gas has two distinct values, depending on whether the volume or the pressure remain constant during the addition of heat. Thus:

c_p = Specific heat at constant pressure

c_v = Specific heat at constant volume.

Ratio of Specific Heats—The factor or exponent k which, as will be noted, figures importantly in compression calculations, is the ratio between the specific heat of a gas at constant pressure, to its specific heat at constant volume. Thus:

$$k = c_p/c_v$$

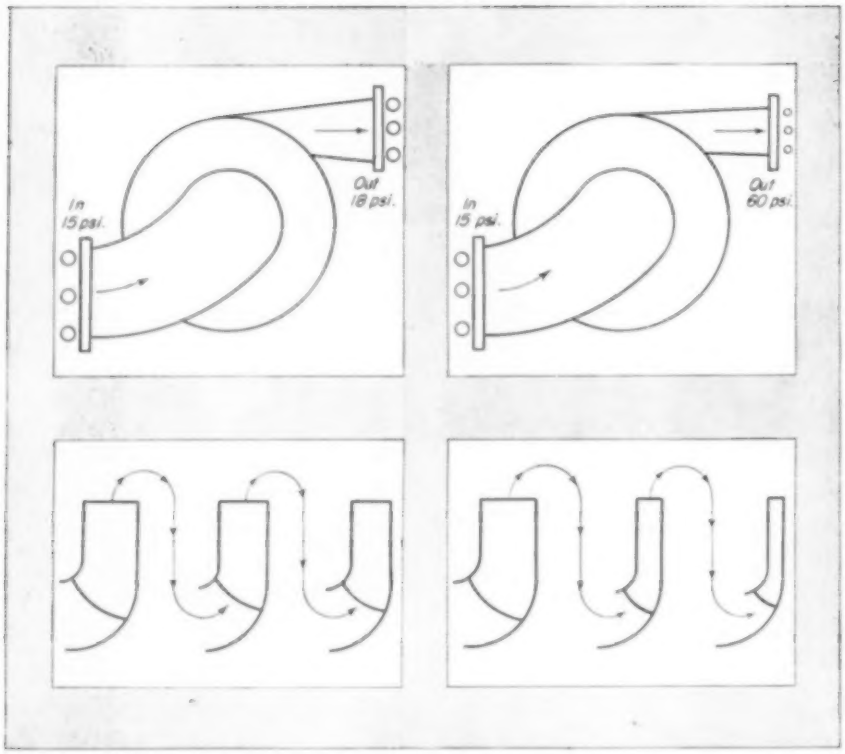
Types of Compression

Adiabatic Compression occurs when no heat is added to or removed from the gas during compression. The characteristic equation for adiabatic compression is:

$$pv^k = Constant$$

and adiabatic compression is further characterized by an increase in temperature during compression.

Isothermal Compression occurs when heat of compression is removed during compression, so that the tem-



4 Sketch at the top suggests how the volume of air compressed to 3,000 ft. head in each of three stages will be reduced at discharge to about 80 percent of inlet volume. Lower sketch indicates area reduction in the stages

5 Sketch at the top suggests how the volume of Freon 11 compressed to 3,000 ft. head in each of three stages will be reduced at discharge to 25 percent of inlet volume. The lower sketch indicates area reduction in the stages

perature of the gas remains constant. The characteristic equation for isothermal compression is:

$$pv = \text{Constant}$$

Polytropic Compression is characterized by the equation:

$$pv^n = \text{Constant}$$

When $n = 1$, the polytropic compression is isothermal; when $n = k$, it is adiabatic. If reference is made to Fig. 1, which shows gas compression on the usual pressure-volume diagram, it will be seen that the slope of the compression curve is a function of the value of the exponent n. Generally, centrifugal compressors are not cooled and, should compression take place with 100 percent efficiency, it would be adiabatic. However, the inefficiency of the compressor results in the addition of heat during compression. As a result, the actual compression in an uncooled centrifugal compressor is polytropic with a value of n greater than k.

Compression Ratio

Ratio of Compression is the ratio between the absolute discharge pressure and the absolute suction pressure:

$$r = \frac{\text{absolute discharge pressure}}{\text{absolute suction pressure}} = p_2/p_1$$

Capacity—The capacity of a centrifugal compressor is the actual quantity of air or gas compressed and delivered, expressed in cubic feet per minute at conditions of temperature and pressure at the compressor intake.

Standard Conditions — Because volume changes occur in compressible fluids with pressure and temperature changes, it is generally convenient to establish some standard basis of comparison to which any set of actual conditions can be converted. A certain difficulty, however has been introduced by the unfortunate fact that different standards have been adopted by different engineering groups.

For instance, the A.S.M.E. Power Test Code has established the definition of Standard Air as air at a temperature of 68 deg. F., a pressure of 14.7 psi. abs. and a relative humidity of 36 percent. This definition is likewise adopted by the Compressed Air Institute. Gas industries use 60 deg. F. as the temperature of standard air, while in the natural gas pipe line field, it is customary to refer to a pressure of 14.4 psi. abs. as standard. It follows, therefore, that in all calculations involving conversion from "standard" to actual conditions, it is highly important to know the basis used.

Theoretical (Adiabatic) Horsepower is defined as the horsepower required to compress adiabatically the air or gas delivered by the compressor through the specified range of pressures.

Brake Horsepower is the measured horsepower input to the compressor.

Adiabatic Compression Efficiency is the ratio of the theoretical adiabatic horsepower to the brake horsepower.

Compressor-Pump Similarity

The most important fundamental principle to be presented is the dynamical identity of the centrifugal compressor with the centrifugal pump. Both receive mechanical energy from an outside source and, by means of rotating impellers, transform this into pressure energy in the fluid pumped. A compressor is composed of the same basic structural parts as a centrifugal pump. It has an impeller (or a series of impellers) mounted on a shaft, which transmits energy to the fluid it handles by centrifugal action. This fluid is accelerated in the impeller and its velocity is ultimately converted into additional pressure by a gradual deceleration in the volute or diffuser which surrounds the impeller.

Even in appearance, the centrifugal compressor differs but little from a centrifugal pump, as may be noted from a comparison of the equipment illustrated in Figs. 2 and 3. The first of these represents a six-stage centrifugal boiler-feed pump while Fig. 3 illustrates a three-stage compressor designed to handle Freon gas for refrigeration application. It is only through the fact that the exposed impellers of the compressor are of varying width that it can be recognized as a compressor. The variation in the impeller width, of course, is necessitated by the fact that a gas, unlike liquids, is compressible and therefore undergoes a reduction in volume as it passes through successive compressor stages.

The centrifugal force developed depends both on the peripheral speed of the impeller and on the density of the fluid in question. On the other hand, the mechanical energy transformed to pressure and velocity energy of fluid pumped, per pound of fluid, is independent of the fluid itself. Therefore, for a given machine, operating at a given speed and handling a given inlet volume, the mechanical energy applied —and transferred to the fluid—in foot-pounds per pound of fluid pumped is approximately the same for all fluids, regardless of density or type, whether the fluid be mercury or hydrogen.

Furthermore, the head generated by an impeller, expressed in foot-pounds

per pound (i.e., feet head) of the fluid handled, is strictly a function of the peripheral speed of the impeller, regardless of the type of fluid. Thus, a pump impeller which develops a head of 100 ft. of water, for example, will develop at the same speed 100 ft. head of air when handling air.

The only fundamental difference between centrifugal pumps and centrifugal compressors is that the former handle liquid fluids which are not appreciably compressible, while compressors handle gaseous fluids which are quite compressible.

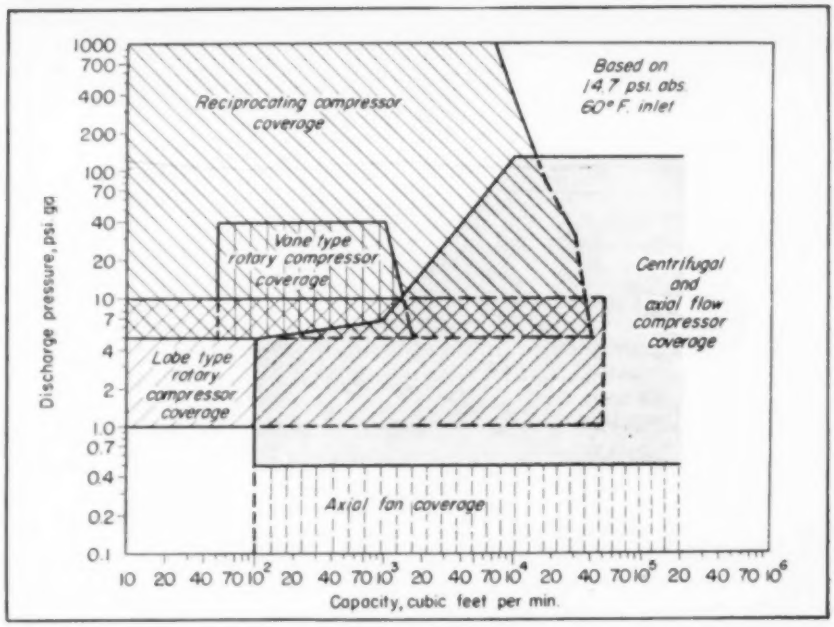
Compressing a gas is nothing more than forcing a given volume or weight of molecules to occupy less total space by applying pressure. This immediately indicates that different forces of compression will be required, depending on the weight and initial spacing or distribution of the molecules, that is, depending on the specific gravity of the gaseous fluid in question. For gases of low molecular weight (low specific gravity) such as air (molecular weight = 28.95), a column say 3,000 ft. high (3,000 ft. of head) would compress the bottom layer very little. If, however, a heavy gas such as Freon 11 (molecular weight = 137) is involved, a similar column of gas 3,000 ft. high will compress the bottom layers very appreciably.

Effect of Mol Weight

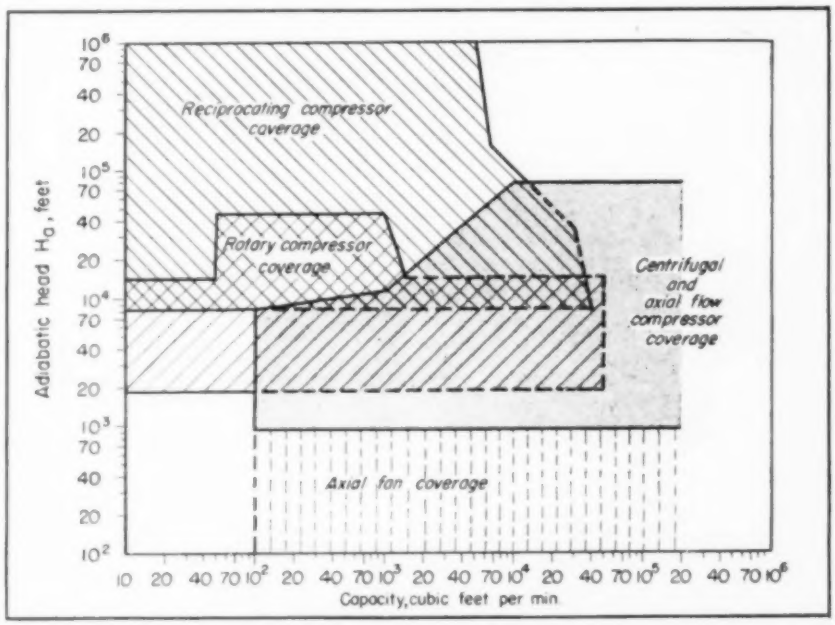
Thus, assume a three-stage centrifugal compressor with 24½-in. impellers, operating at 4,200 r.p.m. In handling air, the outlet volume at the discharge pressure will be approximately 80 percent of the inlet volume (see Fig. 4, top). If, on the other hand, the compressor is used on Freon 11, a much heavier gas, the outlet volume at discharge pressure will be but 25 percent of the inlet volume (see Fig. 5, top). Thus, in the case of a multistage centrifugal compressor, the relative areas of the successive stages vary depending on the rate of volume change, which in turn is dependent upon the specific gravity of the gaseous fluid handled as well as on the head developed and the value of k. This is illustrated in the sketches at the bottom of Figs. 4 and 5 and explains why a given multistage pump can efficiently handle liquids as different as water and gasoline, while a multistage compressor must be made up of different area-stage combinations, depending on the nature of the gas.

There are a few additional differences between pumps and compressors. One such difference has to do with permissible stage pressures. When handling liquids, the heads per stage are limited mainly by efficiency considerations, by interstage pressures which lead to interstage leakage and cutting action and by the erosive action at the impeller tips and in the casing in conjunction with excessively high fluid velocities. In centrifugal compressors, the maximum permissible heads per stage are limited by the critical velocities of the gas or by the strength of the impeller material used. The critical fluid velocity is actually the acoustic velocity, that is the velocity of sound in the fluid being compressed. At the present time it is believed that fluid velocities within the compressor should not exceed this critical velocity. As a matter of fact, and referring specifically to existing designs, considerable noise may be developed should the gases pumped approach too near to this velocity.

Since fluid velocities are inherently related to the peripheral velocity through well known relations, the acoustic velocity places a definite limit upon peripheral speeds and, hence, upon the head generated per stage. However, since acoustic velocities vary for different gases, the maximum permissible heads per stage are likewise a function of the gas itself. The acoustic velocity of most Freon gases, for instance, is 450 ft. per sec. which thus definitely limits the peripheral speed



6 Chart of approximate field for compressor types based on discharge pressure



7 Chart of approximate field for compressor types based on adiabatic head

of Freon compressors. In the case of lighter gases (i.e., air, for which the acoustic velocity is 1,100 ft. per sec.), the limitation no longer comes from this source, but rather from strength-of-materials considerations.

Hence, when handling air, present recommended maximum peripheral speeds are approximately 800 ft. per sec. (9,800 ft. head per stage).

Compressor Applications

All compression equipment is classified into three general divisions, including: (1) Reciprocating displacement type; (2) Rotary displacement type, and (3) Centrifugal type (radial or axial flow).

The first two groups are generally called positive displacement compressors. The reciprocating compressor has been familiar to engineers for a great many years and need not be discussed or described here. Rotary displacement compressors are manufactured according to a great many different principles and are generally divided into several types, such as sliding vane, hydraulic piston, cycloidal, eccentric roller, etc.

Much like centrifugal pumps, of which centrifugal compressors are first cousins, the latter are subdivided into a great many groupings.

All types of compression equipment may be used for single-, double- or multiple-stage compression. Occasionally, a multiple-stage compressor installation may consist of stages in each of two or more of these types. For instance, a centrifugal compressor may be used as the first stage of an installation and discharge into the suction of a single- or multiple-stage reciprocating compressor.

Each of the three main types of compression equipment has a field of application where it is most profitable and economical, but these fields overlap each other over a relatively broad range. In locating these fields of application, it is necessary first to select a set of coordinates through which these fields may be described. It is customary to present the pressure-capacity coverage of centrifugal compressors with the pressures plotted as the ordinates and the capacities as abscissas. Because of the large number of factors involved and of the wide range of conditions under which compression equipment is applicable, it would appear almost impossible to establish a common denominator capable of outlining categories into which any type of compressor can be circumscribed. As already noted, the performance of compressors is materially affected by the density and characteristics of the gaseous fluid being handled. This factor, incidentally, is much more important with centrifugal compressors than with either of the two positive displacement type machines.

Consequently, up to this day, centrifugal compressors have been most generally rated on what is termed "Equivalent Air Pressure," or EAP. This term represents the discharge pressure in psi. ga. of a centrifugal machine at its rated operating speed and capacity when handling a gas of the same density and specific heat ratio as normal air at an atmospheric inlet pressure of 14.7 or 14.4 psi. abs. (the practice varies), and an inlet temperature of 60 deg. F. This method, however, requires a considerable number of conversion calculations and is not very practical for rating purposes, since the hydrodynamic performance of the centrifugal compressor does not follow simple laws on a pressure basis.

The most satisfactory method, therefore, is to rate centrifugal compressors in the same manner as centrifugal pumps, that is on the basis of a head expressed in feet. Thus, throughout the analysis which will follow, reference will be made to the "Adiabatic Heat Head," H_a, expressed in foot-pounds per pound, or feet. In this manner, it becomes possible to rate and analyze compressors on the basis of head-capacity curves, exactly as in the case of centrifugal pumps.

Capacities are generally expressed in cubic feet per minute, although once in a while cubic feet per hour or even million cubic feet per day may be used. This capacity is measured under inlet conditions and, therefore, for rating purposes in conjunction with EAP values, at 14.7 or 14.4 psi. abs. and 60 deg. F.

Authorities disagree rather violently on the question of what represents the most plausible subdivision of the entire compressor field between the various types of compressors. A great number of charts have been published in the past, all at some variance with each other. At the risk of adding fuel to the controversy, the author has prepared his own interpretation of such a subdivision of the field. Fig. 6 presents a composite chart on the basis of discharge pressures with 14.7 psi. abs. inlet pressure and 60 deg. F. temperature. Fig. 7 shows the same coverage expressed in "Feet of Adiabatic Head," H_a. Needless to say, the area assigned to the centrifugal compressor is constantly subject to expansion leftwards and upwards. It must be mentioned, incidentally, that higher adiabatic heads than shown in Fig. 7 are attainable with centrifugal compressors in certain special cases, since it may be practical sometimes to install several machines operating in series, with intercoolers between the consecutive steps, thus reaching very high final discharge pressures. The upper limit in such an arrangement is reached when the inlet conditions to the last compression step are such that the combination of inlet capacity and adiabatic head fall beyond the recommended limits indicated in Fig. 7.

(Editor's Note: The second part of Mr. Karassik's article, to follow in an early issue, will deal with adiabatic head and its calculation for air and perfect gases.)

Oxygen in the Blast Furnace

IN A RECENT talk before the blast furnace and raw materials committee of the A.I.M.E., William Bennett of Carnegie-Illinois Steel Corp. discussed some limitations of the use of oxygen in the blast furnace.

Some of the things we would probably have to do to utilize higher blast heat would be: (1) Induce more direct reduction in the hearth. (2) Provide greater free path for the furnace gases through the stock by: (a) Use of sized material; (b) use of leaner slags or at least more easily melted slags; (c) change of furnace design; (d) use of strong coke; (e) use of beneficiated material such as sinter.

There are limitations on raising the temperature of the hot blast before it enters the furnace. The use of oxygen enriched blast is, in many respects, almost identical in its effects. Both increase the temperature of the available heat in the hearth without much altering the quantity of heat. A notable point to mention in connection with oxygen enrichment is the fact that for the same amount of carbon burned at the tuyeres, the oxygen enriched blast actually brings less heat to the hearth than the air blast when both are preheated to the same temperature. Some of the factors which limit the amount of oxygen enrichment are: (1) Heat leaving the hearth must equal the shaft requirements; (2) top heat must be maintained at a minimum of 230 deg. F.; (3) retarded slag formation may cause irregular working; (4) lumpy material (ore and stone) giving wide variations in amount of direct reduction; and (5) furnaces in which the coke rate is already low. At the present time, however, the main limitation on the use of oxygen is still financial.

Mass and Heat Transfer In Agitator Systems

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HOW AGITATOR SYSTEMS FOR MASS AND HEAT TRANSFER CAN BE DESIGNED BY SCALING-UP FROM PILOT PLANT DATA

This is the second of two articles dealing with the performance and design of agitator systems. The first article considered agitator power requirements and gas liquid contacting. It appeared last month, pages 119-125. Since the two articles are so closely related, the equation numbers in this one are continued in sequence from last month to avoid confusion.

TWO TYPES of mass transfer will be considered: (1) between solids and liquids and (2) between immiscible liquids. In the first case there are three controlling variables, the thickness of the film through which the material must diffuse, the rate of diffusion and the degree of saturation of the solution (the driving force across the film). Hixon and Baum[8] obtained a correlation of the form:

$$\frac{KD}{d} = c\left(\frac{ND^2\rho}{\mu}\right)^a\left(\frac{\mu}{\rho d}\right)^b \quad \ldots\ldots (6)$$

where K = mass transfer coefficient, $\frac{\text{(lb.)}}{\text{(hr.) (ft.)}^2\text{ (lb.)}}\frac{\text{(ft.)}^3}{}$;
D = vessel diameter, ft.; d = diffusivity, $\frac{\text{(lb.) (ft.) (ft.)}^3}{\text{(hr.) (ft.) (lb.)}}$;

c = a constant dependent on the geometry of the system; N = shaft speed, rev. per sec.; ρ = density of solution, lb. per cu. ft.; μ = viscosity of solution, lb. per ft. sec. or hr.; a = constant; b = constant = 0.5 approximately.

The amount of diffusivity data is limited so the equation in the form given above has only a restricted use. It can be used advantageously, however in "scaling up" pilot plant data by rearranging the equipment to give (using D proportional to L):

$$\frac{K_1L_1}{K_2L_2} = \left(\frac{N_1L_1^2}{N_2L_2^2}\right)^a \quad \ldots\ldots (7)$$

The constant a is about 0.6 for unbaffled tanks and is 1.0 for "off-set" propellers[8].

Example 1 — Aldehyde impurities are being removed from an alcohol in a pilot plant mixing tank by the following procedure. Slacked lime flakes at the rate of 0.05 lb. per min. and alcohol at the rate of 1 gal. per min. are fed together into a 5 gal. unbaffled mixing vessel. The mixture overflows and is separated by gravity. The spent lime is discarded. A plant-sized unit to process 600 gal. per hr. is to be built to do the same job. Specify the plant-size equipment, supplying the same type of data as is given below for the pilot plant equipment.

Tank: (1 ft. D) (1 ft. H), unbafflled;
Impeller: paddle; (3 in. L) (1 in. W), 600 r.p.m.;
Motor: 1/10 hp.

To solve the problem, assume geometric similarity and use Eq. (7) as follows (K must be the same in both cases):

$$\frac{K_1L_1}{K_2L_2} = \left(\frac{N_1L_1^2}{N_2L_2^2}\right)^{0.6}$$

Tank volume (plant) = (5/1)(600/60) = 50 gal.; $L_2 = L_1(50/5)^{\frac{1}{3}} = 3(50/5)^{\frac{1}{3}} = 6.45$ in.; $W_2 = W_1(50/5)^{\frac{1}{3}} = (1)(50/5)^{\frac{1}{3}} = 2.15$ in.; $N_2 = N_1(L_1/L_2)^{0.88} = 600(3/6.45)^{0.88} = 465$ r.p.m.; The power is obtained by using Eq. (5) $P_2 = (N_2/N_1)^{2.88}(L_2/L_1)^{4.7}P_1 = (465/600)^{2.88}(6.43/3)^{4.7}(0.1) = 1.75$ hp.

Note—There are two cases of mass transfer which should be given special consideration. For these cases, agitation may not be entirely the answer to the control of the operation.

Case I. When diffusion through the solid is the controlling factor (e.g. leaching). Here agitation will help up to the point where the material is carried to the solution from the interface faster than it can diffuse through the solid. At this point the benefit of agitation will cease, and further increase in agitation intensity will not increase the process speed.

Case II. When a slow chemical reaction is taking place (exchange of material from solid to liquid phase where it reacts in the liquid phase). If the solution is being fed with material faster than it can consume it by reaction, then increased agitation will not be able to speed the process.

Mass transfer between two immiscible liquids is more involved than that between solids and liquids. When contacting a solid and a liquid, the interfacial area does not change with the intensity of agitation. When contacting a liquid with a liquid, the interfacial area changes markedly with agitation. This fact makes the system more difficult to study and there has been relatively little information recorded in the literature concerning it. Where all other variables are held constant and a baffled tank is used, the size may be changed (holding to geometric similarity) by using as an approximation:

$$\frac{K_1}{K_2} = \frac{N_1L_1}{N_2L_2} \quad \ldots\ldots (8)$$

HEAT TRANSFER FILM COEFFICIENTS

FILM COEFFICIENTS

Heat transfer film coefficients for various fluids moderately agitated in cylindrical vessels equipped with either jacket or coils. (Film coefficients h_j (jacket) and h_c (coils) expressed in B.t.u. per hr. per sq. ft. per deg. F.)

Fluid	Temp. Deg. F.	Film Coeff. h_j	Film Coeff. h_c	Specific Gravity	Viscosity c. p.	Specific Heat	Thermal Conductivity
Water	150	720	1070	0.980	0.43	1.0	0.381
Water	50	450	710	1.00	1.31	1.0	0.333
Brine–25 per cent NaCl	100	380	610	1.179	1.6	0.81	0.283
Methyl alcohol	100	220	350	0.775	0.46	0.62	0.120
Ethyl ether	100	200	310	0.698	0.20	0.52	0.079
Ethyl acetate	100	200	310	0.881	0.39	0.49	0.089
Benzene	100	170	270	0.860	0.50	0.42	0.091
Ethyl alcohol	100	170	270	0.774	0.86	0.66	0.104
Sulphuric acid 90 per cent	100	140	230	1.80	12.0	0.40	0.162
Carbon tetrachloride	100	140	210	1.56	0.79	0.20	0.065
Iso-propyl alcohol	100	125	200	0.770	1.42	0.62	0.088
n-Butyl alcohol	100	120	200	0.795	1.90	0.605	0.096
Kerosene	100	115	185	0.800	1.50	0.49	0.084
Gas oil	100	98	160	0.845	2.11	0.47	0.077
Glycerol–92 per cent	100	78	135	1.224	60.0	0.62	0.171
L-M oil	100	40	75	0.91	26.	0.45	0.072
Light lubricating oil	100	35	60	0.88	45.	0.46	0.074
Heavy lubricating oil	100	28	50	0.90	95.	0.45	0.073
A-12 oil	100	17	31	0.88	425.	0.46	0.077

CORRECTION FACTORS

VESSEL DIAMETER CORRECTION FACTOR

Dia. (ft.)	Factor
1	1.0
2	0.96
4	0.92
6	0.90
8	0.88
10	0.86

POWER CORRECTION FACTOR

Degree of Agitation	Power (Hp. per Gal.) Jacket	Coil	Factor
Mild	0.0005	0.0006	0.85
Moderate	0.0010	0.0012	1.00
Vigorous	0.0025	0.0030	1.24

HOW TO USE CORRECTION FACTORS

Example: Correct the film coefficient for a 4 ft. diam. jacketed tank using 0.0025 hp. per gal. for water at 150 deg. F. $h_j = (720)(0.92)(1.24) = 820$.

Heat Transfer

Chilton, Drew and Jebens[1] have shown that film coefficients for heat transfer for the agitated fluid for coil or jacket in a tank equipped with a flat paddle agitator can be represented by the following equations:

For jacket: $$h_j = 0.36\,\frac{k}{D}\left(\frac{L^2 N \rho}{\mu}\right)^{2/3}\left(\frac{C\mu}{k}\right)^{1/3}\left(\frac{\mu}{\mu_j}\right)^{0.14} \quad \ldots\ldots\ldots(9)$$

For coils: $$h_c = 0.87\,\frac{k}{D}\left(\frac{L^2 N \rho}{\mu}\right)^{0.62}\left(\frac{C\mu}{k}\right)^{1/3}\left(\frac{\mu}{\mu_c}\right)^{0.14} \quad \ldots\ldots\ldots(10)$$

where h = film coefficient of heat transfer, B.t.u. per hr. per sq.ft. per deg. F.; D = tank diameter, ft.; k = conductivity of liquid, B.t.u. per hr. per deg F. per ft. Subscript j refers to the agitated fluid next to a jacket and subscript c to the agitated fluid next to a coil.

To use Eqs. (9) and (10) for impellers other than flat paddles, it has been assumed that equal power input will effect equal performance; other variables being held constant. Based on this assumption, a film coefficient table was compiled. It gives jacket and coil heat transfer coefficients in a 1 ft. diameter tank at moderate degree of agitation for various liquids. Corrections to be used for other tank sizes and degrees of agitation are also shown in the table. Moderate degree of agitation was arbitrarily taken as a power input of 0.001 hp. per gal. when run in water for a jacketed unbaffled tank. Using as basis a one-foot diameter tank and paddle 0.6 feet long, this power input corresponds to a certain rotational velocity found from Eq. (5) and used in Eq. (9) to give heat transfer coefficients for various liquids. The constant used in Eq. (5) was 0.00025 which applies for flat paddles[2]. In the case of coil in tank, because of the baffling effect of the coil, the power input for a given speed or degree of agitation was taken as 20 percent higher than for jacketed or unbaffled tanks.

To scale up a system using geometric similarity it can be seen from Eqs. (9) and (10) that:

$$\frac{h_1}{h_2} = \left(\frac{L_1}{L_2}\right)^{1/3}\left(\frac{N_1}{N_2}\right) \quad \ldots\ldots\ldots(11)$$

Example 2—A reaction being run in an ethyl alcohol solution absorbs heat at a rate of 400 B.t.u. per hr. per lb. of alcohol when run at 100 deg. F. It is proposed to run the same reaction in an agitated vessel 4 ft. in diameter, the liquid height in the vessel also being 4 ft. Steam at 5 lb. per sq.in. gage (227 deg. F.) is available. Determine the agitator requirements.

There will be a total heating demand of: $q = (\pi/4)\,D^2 H \rho \Delta Q = (\pi/4)\,(4)^2\,(4)\,(0.774)\,(62.4)\,(400) = 967{,}000$ B.t.u. per hr.

The area available for heat transfer is $A = \pi DH + (\pi/4)D^2 = (\pi)\,(4)\,(4) + (\pi/4)\,(4)^2 = 63$ sq.ft.

The temperature difference between the two liquids is:

$\Delta T = 227 - 100 = 127$ deg. F.

The film coefficient for the steam condensate will be relatively high, and, therefore, the steam film resistance can be neglected. Then $h_j = q/(A\Delta T) = 967{,}000/(63)(127) = 121$.

According to the table h_j for ethyl alcohol in a 1 ft. diameter tank with a power of 0.001 hp. per gal. will be 170, for a 4 ft. inside diameter reactor, h_j will be $(170)(0.92) = 156$. Accordingly, the power required will be considerably less than 0.001 hp. per gal. For 0.0005 hp. per gal. $h_j = (170)(0.92)(0.85) = 133$.

Therefore, 0.0005 hp. per gal is sufficient. Using this value for power as a basis, the power requirement will be: $(0.0005)\,(7.48)\,(\pi/4)\,(4)^2 = 0.188$ hp. Note that this is the power which the impeller would draw if running in water. A consideration of Eq. (5) indicates that the impeller would draw slightly less power in alcohol. Therefore, a stirrer which will draw ¼ hp. will be ample.

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Cost Relationships in Preliminary COST ESTIMATION

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PRELIMINARY ESTIMATION IS FACILITATED BY A STUDY OF THE WAY IN WHICH RELATIVE COSTS VARY WITH SIZE AND TYPE OF PLANT

PROCESS EQUIPMENT COSTS

In an earlier article in our September issue the author described a successful technique for preliminary cost estimation of process plants that is used by a large engineering and construction firm and is, in general, applicable to most engineering department needs. This concluding article is a study of estimates of 14 process plants, some of which are compared with actual costs to show the accuracy that can be obtained and the types of error that may occur. The article compares percentage costs for various plant elements in plants of varying size and type and presents a simplified method for quick estimates of complete plants, requiring detailed estimation of the process equipment only.

AN EARLIER article (Sept. 1947, pp. 130-133) discussed methods for preliminary estimation of the several classes of construction work and other costs involved in process plants. Total cost was broken down into Total Physical Cost, comprising yard improvements, buildings including services, process equipment, process piping, electrical installations, and service facilities; and Total Other Cost, comprising contingency allowance, insurance and taxes, premium time payments, field office expense including temporary construction, and home office expense including overhead.

From a study of 14 plant estimates, approximate relations among the expenditures for the various kinds of costs can be derived, both for plants covering a considerable range in size, and for plants of varying type. A survey of these relations and the presentation of a simplified system for approximating the results of a detailed preliminary estimate several weeks before the latter can be completed, are the purposes of this present article.

The 14 process plants for which preliminary estimates are compared in this study are listed in Table I, which shows when or whether the plants were built, whether they were pilot, experimental or full scale plants, and whether they were primarily indoor or outdoor plants.

For two of these plants, the type of process has been classified as solids processing, since the raw materials, intermediate products and finished products were handled principally in the solid state. On the other hand, five of the plants are referred to as fluids processing plants since in these the raw materials, intermediate products and finished products (including byproducts) are predominantly fluid. The remaining seven plants have been classified as solids and fluids processing plants.

What the Plants Made

A relatively wide variety of products was handled by the 14 plants. Plants Nos. 1 and 2 were experimental full-scale units in which equipment was tested for information on process and mechanical design. Plants Nos. 3, 4 and 5 were pilot plants. The first of these extracted certain constituents from beef blood, while the last two were built for research on the production of gasolines and synthetic rubbers from mineral oils.

Plants Nos. 6 to 14 were full scale plants for the production of briquets, catalysts, rayon pulp, synthetic detergents, insecticides, etc.

The major part of the processing equipment was located indoors for all plants, except plants Nos. 1, 2 and 9. For the smaller plants, buildings were generally of masonry construction and, for the larger plants, of steel construction with corrugated asbestos or similar siding. The control buildings for plant No. 9 were of masonry. Construction costs are available at present only for plants Nos. 6 through 11. Construction work for these plants was completed during the years 1942 to 1946. For these plants the actual and the estimated relative (percentage) costs have been compared in Table II which was prepared by dividing the Total Physical Cost of each plant (material plus labor) into each of the several items listed in the column headings of the table.

Table II indicates that a preliminary estimate reflects the relative cost of each of the major subdivisions of Total Physical Cost with reasonable accuracy, not only for the weighted averages shown at the bottom of the table, but also for the ranges covered by the six plants.

The ranges between the lowest and

highest values of estimated costs which appear below each item in Table II are comparable to those for actual costs. In every instance, except two, the plant which gave the lowest (or highest) estimated value for any particular item also gave the lowest (or highest) actual value.

The correspondence between actual and estimated relative costs indicates that overruns or underruns due to changes in the scope of the work and to all other causes apparently distribute themselves in accordance with estimated relative costs.

A comparison between estimated and actual relative costs was also made after prorating the items included under Total Other Costs over the Total Physical Costs. This comparison is given in the last two lines of Table II. To make this comparison the contingency allowance, field and home office expenses, were prorated over the material plus labor costs, while the insurance and taxes, and the premium time cost, were prorated over the labor costs only. For actual cost, it was, of course, unnecessary to prorate the contingency since, if this item is spent, it reappears elsewhere while, if it is not spent, total actual costs are less than total estimated costs.

Thus far the discussion has been concerned only with relative or percentage costs. Table III, which is expressed in dollars, gives the difference between actual and estimated total costs for each of the six plants. The differences were all overruns but the overrun tabulation in Table III indicates that these quantities were not excessive since they must necessarily absorb all changes in scope from the time a preliminary estimate is first prepared until the completion of construction.

Table I—Process Plants for Which Estimates Were Made

Plant No.	Built or Not*	Year Built or Estimated	Approximate Total Cost, $	Type of Plant	Type of Process
1	U.C.	1947	100,000	Experimental†	Fluid processing
2	U.C.	1947	150,000	Experimental†	Fluid processing
3	N.C.	1947	400,000	Pilot plant	Fluid processing
4	N.C.	1946	400,000	Pilot plant	Fluid processing
5	N.C.	1946	500,000	Pilot plant	Fluid processing
6	C.	1946	1,000,000	Full scale	Solids and fluid processing
7	C.	1943	1,500,000	Full scale	Solids processing
8	C.	1944	1,500,000	Full scale	Solids processing
9	C.	1946	2,000,000	Full scale†	Fluid processing
10	C.	1942	2,250,000	Full scale	Solids and fluid processing
11	C.	1943	2,500,000	Full scale	Solids and fluid processing
12	U.C.	1947	4,000,000	Full scale	Solids and fluid processing
13	N.C.	1946	8,500,000	Full scale	Solids and fluid processing
14	N.C.	1942	15,000,000	Full scale	Solids and fluid processing

* U.C., under construction; N.C., not constructed; C., constructed, actual costs available.
† Outdoor plants.

Table II—Comparison of Relative Physical Costs

Plant No.	Estimated or Actual Costs	Percentages of Total Physical Costs: Yard Improvements	Buildings Including Services	Process Equipment	Process Piping	Electrical Installations	Service facilities
6	Estimated	2.2	12.6	60.9	8.4	8.7	7.2
	Actual	1.5	16.5	57.6	8.7	7.6	8.1
7	Estimated	6.1	14.5	60.4	4.5	7.9	6.6
	Actual	5.7	17.3	55.8	5.2	8.2	7.8
8	Estimated	11.5	13.1	57.0	4.5	7.5	6.4
	Actual	8.1	15.6	56.1	5.1	9.0	6.1
9	Estimated	2.0	8.4	43.5	28.6	5.3	12.2
	Actual	2.3	8.5	41.2	27.7	9.7	10.6
10	Estimated	4.4	33.9	35.9	4.7	6.6	14.5
	Actual	2.9	34.1	30.5	6.3	7.2	19.0
11	Estimated	3.4	15.4	54.7	10.1	5.2	11.2
	Actual	4.6	16.1	53.1	9.8	4.5	11.9
Weighted averages Total cost averages*	Estimated	4.7	17.6	50.5	10.3	6.5	10.4
	Actual	4.3	17.8	47.6	10.9	7.3	12.1
	Estimated	4.9	17.9	50.3	10.0	6.7	10.3
	Actual	4.4	17.7	47.1	10.6	7.3	12.9

* After prorating Total Other Costs over Total Physical Costs.

Table III—Net and Gross Overruns

Plant No.	Estimated Total Cost	Actual Total Cost	Net Overrun	Estimated Contingency	Gross Overrun	Overrun, Percent: Net	Gross	Net Corrected*
6	$800,000	$955,000	$65,000	$70,000	$135,000	7.3	15.2	4.6
7	1,165,000	1,445,000	280,000	75,000	355,000	24.0	30.4	3.4
8	1,220,000	1,430,000	210,000	75,000	285,000	17.2	23.4	3.9
9	1,630,000	1,960,000	330,000	120,000	450,000	20.1	27.6	10.9
10	1,985,000	2,115,000	130,000	170,000	300,000	6.5	15.1	6.5
11	2,295,000	2,540,000	245,000	100,000	345,000	10.7	15.0	2.7
Weighted averages	.....	.....	.....	.....	.....	13.7	20.4	5.9

* Corrected for changes in scope and escalator clauses.

Overrun Distribution

In Table III the net overrun refers to the difference between actual and estimated total cost expressed as a percentage of estimated total cost. This percentage averaged 13.7 percent and varied from 6.5 to 24.0 percent. The gross overrun refers to the net overrun plus the estimated contingency expressed as a percentage of the estimated total cost. This percentage averaged 24.4 percent and varied from 15.0 to 30.4 percent.

In a calculation made to compare actual and estimated total cost for each of the major subdivisions of construction in plants Nos. 6 to 11, it was found that the actual Total Physical Cost averaged 10 percent higher than the estimated cost, a difference due almost entirely to changes in scope. The actual costs for yard improvements and process equipment were substantially identical with estimated costs for the average of the six plants. The actual building costs, including services, averaged 13 percent higher than the estimated costs although buildings excluding services averaged 20 percent higher, while services alone were 32 percent lower.

Process piping averaged 13 percent higher, being nearly identical for plants Nos. 6 and 11, but ranging from 13 to 42 percent higher than estimated costs in the remaining plants. Actual costs for electrical installations and service facilities were about 30 percent higher than estimated costs on the average.

The differences between actual and estimated costs are due primarily to: (a) changes in scope of the actual work, compared to that originally estimated; (b) escalator clauses; and (c) incorrect estimates of physical costs. Such incorrect estimates include: (1) incorrect quantity estimates for items such as the size of buildings, the length of a transmission line, the size of a substation, the amount of raw material storage required, etc.; (2) incorrect quality estimates due to basing the estimate on a more or less expensive type of installation than is actually used; and (3) incorrect pricing data due to incorrect unit or other prices for estimating the type of work on which the preliminary estimate is based.

On the average the 10 percent overrun for the six plants for Total Physical Costs was distributed to changes

m scope, 7.8 percent; escalator clauses, 0.9 percent; and incorrect estimates, 1.3 percent.

If changes in scope and escalator clauses are deducted from the net overrun given in Table III, this overrun averages only 5.9 rather than 13.7 percent. Furthermore, as indicated in the last column of Table III, it exceeds 10 percent for only one plant. Hence it is evident that preliminary estimates can be prepared with an accuracy better than 10 percent, based on the scope of work defined by the estimates.

On the basis of data for only one of the six plants, incorrect estimates are due primarily to unit prices and other pricing data selected by the estimator for the work. Incorrect quantity estimates are responsible for the remainder since incorrect quality estimates are not significant, indicating that materials of construction were properly selected. The total estimating error for this plant was accounted for by pricing data, 75 percent; quantity estimates, 20 percent; and quality estimates, only 5 percent. For the average of the six plants, incorrect estimates were distributed evenly between material and labor. However, this distribution varied widely from one plant to another.

Relative Costs

Considering only the preliminary estimates for the 14 plants listed in Table I, it is desirable to analyze the relative or percentage costs for the major subdivisions of design and construction work. The relative costs so far considered for plants Nos. 6 to 11 will not in general agree with those to be considered below since in those already considered, the preliminary estimate and actual costs for each plant were compared after making certain that the work included under each item was identical. However, this work varied from one plant to another. In what follows all estimates have been corrected to include the same work under each item. The more important of these corrections included:

Premium Time—Premium Time was included in only four of the estimates originally so that for what follows these estimates have been adjusted to eliminate this item.

Yard Improvements—The items included under Yard Improvements differed widely from one estimate to another. They have been redistributed between Yard Improvements and Service Facilities as discussed in the author's earlier article.

Buildings—For some of the estimates, building costs included equipment foundations, supports and platforms. These items were segregated and added to process equipment. For other estimates, the process was located in existing buildings. Such estimates, therefore, have been adjusted to include a new building cost.

Furthermore, in what follows, all relative costs have been given on a Total Cost rather than on a Total Physical Cost basis.

Relative or percentage costs for each major subdivision of construction work, for all 14 plants considered, are given in Table IV. Here the plants have been arranged by increasing size as determined by the estimated costs. Weighted averages are also given for plants grouped by costs in the classification of "$100,000 and under," "$100,000 to $500,000," "$500,000 to $1,000,000," etc.

The data are insufficient to include more than one plant in some of these classifications, but even with the limited data available, it is hoped that relative cost trends can be gaged more easily by grouping plants of similar size.

In general, Table IV indicates the

Table IV—Relative Costs, Arranged by Plant Size

Plant No.	Approximate Cost of Plant	Percentages of Total Cost: Total Other Costs*	Yard Improvements	Buildings Including Services	Process Equipment	Process Piping	Electrical Installations	Service Facilities	Total Physical Costs	Piping Plus Equipment
1	$100,000	35.7	....	....	41.3	8.7	8.1	6.2	64.3	50.0
2	150,000	32.7	....	....	43.0	9.4	8.1	6.8	67.3	52.4
3	400,000	28.6	....	15.8	36.4	14.1	5.1	...	71.4	50.5
4	400,000	27.8	....	17.4	35.0	8.6	8.3	2.9	72.2	43.6
5	500,000	26.5	....	14.1	35.2	18.0	4.7	1.5	73.5	53.2
6	1,000,000	23.4	1.6	9.7	46.7	6.5	6.7	5.4	76.6	53.2
7	1,500,000	21.9	4.7	11.3	47.3	3.4	6.2	5.2	78.1	50.7
8	1,500,000	21.6	9.1	10.3	44.7	3.4	5.9	5.0	78.4	48.1
9	2,000,000	26.0	1.4	6.1	32.3	21.3	3.9	9.0	74.0	53.6
10	2,250,000	20.3	3.7	7.8	39.1	11.4	5.6	12.1	79.7	50.5
11	2,500,000	22.2	2.6	12.0	37.4	13.0	4.0	8.8	77.8	50.4
12	4,000,000	24.0	0.7	6.7	47.0	7.2	6.2	8.2	76.0	54.2
13	8,500,000	17.2	1.4	7.6	49.4	12.8	3.1	8.5	82.8	62.2
14	15,000,000	17.4	2.3	8.3	44.3	11.6	3.2	12.9	82.6	55.9
Weighted Averages										
	$100,000 plants	35.7	....	....	41.3	8.7	8.1	6.2	64.3	...
	500,000 plants	28.1	....	14.0	36.3	13.5	6.1	2.0	71.9	...
	1,000,000 plants	23.4	1.6	9.7	46.7	6.5	6.7	5.4	76.6	....
	2,000,000 plants	22.4	3.9	9.5	39.2	11.4	5.0	8.6	77.6	....
	5,000,000 plants	24.0	0.7	6.7	47.0	7.2	6.2	8.2	76.0	....
	10,000,000 plants	17.2	1.4	7.6	49.4	12.8	3.1	8.5	82.8	....
	15,000,000 plants	17.4	2.3	8.3	44.3	11.6	3.2	12.9	82.6	....
	All plants	19.8	2.2	8.5	44.2	11.3	4.1	9.9	80.2	...

* Total Other Costs include home and field office expenses, contingency and insurance and taxes.

Table V—Relative Costs, Arranged by Type of Process

Plant No.	Approximate Cost of Plant	Percentages of Total Cost: Total Other Costs	Yard Improvements	Buildings Including Services	Process Equipment	Process Piping	Electrical Installations	Service Facilities	Total Physical Costs
I: Solids Processing Plants									
7	$1,500,000	21.9	4.7	11.3	47.3	3.4	6.2	5.2	78.1
8	1,500,000	21.6	9.1	10.3	44.7	3.4	5.9	5.0	78.4
Weighted average		21.7	6.9	10.8	46.0	3.4	6.1	5.1	78.3
II: Solids and Fluid Processing Plants									
6	1,000,000	23.4	1.6	9.7	46.7	6.5	6.7	5.4	76.6
10	2,250,000	20.3	3.7	7.8	39.1	11.4	5.6	12.1	79.7
11	2,500,000	22.2	2.6	12.0	37.4	13.0	4.0	8.8	77.8
12	4,000,000	24.2	0.7	6.7	47.0	7.2	6.2	8.2	76.0
13	8,500,000	17.2	1.4	7.6	49.4	12.8	3.1	8.5	82.0
14	15,000,000	17.4	2.3	8.3	44.3	11.6	3.2	12.9	82.6
Weighted average		18.9	2.0	8.2	45.2	11.3	3.8	10.6	81.1
III: Fluids Processing Plants									
1	100,000	35.7	....	....	41.3	8.7	8.1	6.2	64.3
2	150,000	32.7	....	....	43.0	9.4	8.1	6.8	67.3
3	400,000	28.6	....	15.8	36.4	14.1	5.1	....	71.4
4	400,000	27.8	....	17.4	35.0	8.6	8.3	2.9	72.2
5	500,000	26.5	....	14.1	35.2	18.0	4.7	1.5	73.5
9	2,000,000	26.0	1.4	6.1	32.3	21.3	3.9	9.0	74.0
Weighted average		27.3	0.7	9.5	34.4	17.3	5.0	5.8	72.7
IV: Weighted Averages for Plants Ranging from $1,000,000 to $4,000,000									
Solids processing		21.7	6.9	10.8	46.0	3.4	6.1	5.1	78.3
Solids and fluids processing		22.7	1.9	8.6	42.9	9.4	5.5	9.0	77.3
Fluids processing		26.0	1.4	6.1	32.3	21.3	3.9	9.0	74.0

Table VI—Relative Costs of Process Equipment

Plant No.	Percentages of Total Equipment Costs: Foundation	Supports and Platforms	Foundations, Supports and Platforms	Installation*	Equipment†	Total
1	7.1	4.0	11.1	11.3	77.6	100.0
2	6.0	2.8	8.8	10.9	80.3	100.0
3	3.5	2.0	5.5	15.1	79.4	100.0
4	0.6	21.2	21.8	11.0	67.2	100.0
5	3.6	3.0	6.6	15.9	77.5	100.0
6	2.2	1.5	3.7	18.7	77.6	100.0
7	8.8	6.0	14.8	17.0	68.2	100.0
8	8.8	6.1	14.9	17.0	68.1	100.0
9	5.3	12.9	18.2	13.2	68.6	100.0
10	4.1	13.3	17.4	18.4	64.2	100.0
11	8.2	6.7	14.8	5.2	80.0	100.0
12	2.7	8.9	11.6	19.3	69.1	100.0
13	4.2	6.3	10.5	20.2	69.3	100.0
14	4.7	9.4	14.1	19.9	66.0	100.0
Weighted average	4.7	8.2	12.9	18.4	68.7	100.0
Rough "memory" average	5.0	8.0	13.0	17.0	70.0	100.0

* Installation costs include construction equipment rentals.
† Equipment costs are f.o.b. factory with freight allowed to site.

Table VIII—Relative Cost Breakdown for Preliminary Estimates

Size of Plant	Percentages of Total Cost: Total Other Costs*	Yard Improvements	Buildings Including Services	Process Equipment	Process Piping	Electrical Installations	Service Facilities	Total Physical Costs
I: Solids Processing Plants								
Under $1,000,000	25	2	15	45	4	6	3	75
$1,000,000 to $5,000,000	22	4	11	46	4	5	8	78
Over $5,000,000	20	2	10	49	5	4	10	80
II: Solids and Fluid Processing Plants								
Under $1,000,000	28	2	15	37	9	6	3	72
$1,000,000 to $5,000,000	25	4	9	39	10	5	8	75
Over $5,000,000	21	2	8	44	11	4	10	79
III: Fluid Processing Plants								
Under $1,000,000	29	1	15	32	14	6	3	71
$1,000,000 to $5,000,000	27	3	6	31	20	5	8	73
Over $5,000,000	23	3	5	34	21	4	10	77

* Includes home and field office expenses, contingency, and insurance and taxes.

Table VII—Relation of Buildings and Process Piping to Process Equipment Cost

Plant No.	Percent of Total Process Equipment Cost: Buildings	Process Piping	Process Piping as Percent of Process Equipment to Which Piping Is Connected
1	....	21.1	21.1
2	....	21.8	21.8
3	43.4	38.7	38.7
4	39.8	24.5	24.5
5	40.0	51.3	56.3
6	20.8	13.9	66.2
7	23.9	7.2	72.0
8	23.0	7.6	76.0
9	18.9	66.0	66.0
10	20.0	29.2	49.5
11	32.1	34.8	45.2
12	14.2	15.3	46.4
13	15.4	25.9	48.8
14	18.7	26.2	(No information)

trends in relative costs which may be expected with increase in size:

1. Total Other Costs show a fairly consistent reduction from the smallest to the largest plant.

2. Yard Improvements are negligible for smaller plants for which no additional railroad siding, fencing and similar facilities are required.

3. Building costs for plants in which most of the processing equipment is located indoors vary inversely with the size of the plant, due both to the lower unit cost for larger buildings, and to differences in types of construction.

4. Relative costs for process equipment and process piping vary with the type of process as more fully reviewed later.

5. Electrical Installations appear to trend in general from a higher percentage for smaller plants to a lower for larger plants, although these costs depend more on the type of process than the size of plant.

6. Service Facilities show a tendency to increase with the size of plant which is to be expected, since new steam generating equipment and similar facilities are usually required for larger plants, whereas smaller plants are often served by existing facilities.

Table V is similar to Table IV, except that the plants have been arranged by type of process, whether solids processing, solids and fluids processing, or fluids processing.

Initially an attempt was made at a further classification by indoor and outdoor construction, but this proved to be unnecessary. The type of process usually determines whether or not buildings will be required. Solids, and solids and fluids processing plants are generally located indoors. Fluids processing plants, except for those of smaller size, are generally located outdoors.

The weighted averages given in Table V for plants ranging in size from $1,000,000 to $4,000,000 show certain trends:

1. Total Other Costs vary directly with the relative costs of process piping work, that is, being lower for solids processing plants where there is little piping, and higher for fluids processing plants.

2. Process Equipment Costs tend to be higher percentagewise for solids processing plants, and lower for fluids processing plants.

3. Process Piping Costs, of course, are much greater for fluids processing than for solids processing plants.

These conclusions are tentative owing to insufficient data, but may corroborate similar data assembled by others.

Equipment Plus Piping

Tables IV and V also indicate that the sum of Process Equipment and Process Piping Costs is, for all practical purposes, independent of the size and type of plant, at least for the data of this study. This fact is clearly brought out by the last column of Table IV. In general, process equipment and process piping represent about 50 percent of the total cost of a project, regardless of the type of process, and for sizes ranging from $100,000 to $4,000,000. There is some indication that for larger plants this percentage will be nearer 60. As a general rule, however, a rough estimate of the total cost of a project can be obtained by estimating process equipment and process piping costs and multiplying their sum by two.

In Tables IV and V, the percentage costs of process equipment include foundations, supports and platforms, installation (labor) including construction equipment rentals, and equipment (materials) f.o.b. factory, with freight allowed to the site. Table VI gives the cost for each of these items expressed as a percentage of total process equipment costs. The weighted averages given in this table have been modified slightly in the last line of the table to show rough "memory" averages that should be easy to remember.

It is sometimes convenient to express building costs and process piping costs as percentages of total equipment costs. Table VII lists these percentages. In the second column, ap-

plying to buildings, it will be seen that for the smaller plants, in which masonry and other expensive types of construction were used, the percentage costs averaged about 50 and varied from 40 to 60. For the remaining plants, these costs averaged about 20 percent and varied from 14 to 32 percent. Building services, excluding lighting, averaged about 20 percent of the building costs.

The third column of Table VII is simply the ratio of total process piping to total process equipment for the figures given in Table IV. This ratio obviously depends on the type of process. Therefore, the last column of Table VII has been provided to give a similar ratio in which, however, only the total equipment costs for equipment connected to the piping is used. Neglecting the first five plants, which were either pilot or experimental units, this ratio varied between the comparatively narrow limits of 45 percent for plant No. 11 and 76 for plant No. 8. Piping costs for both of these plants were estimated as discussed in the first article (*Chem. Eng.*, September 1947, p 132). Two of these estimates will be discussed to indicate the accuracy that can be expected by using these procedures.

For plant No. 6 only a small part (21 percent) of the total process equipment is connected to piping. Since all of the piping is rather complex and could not easily be sketched out on preliminary arrangement drawings within the time available, it was assumed that total process piping costs, including insulation, would amount to 70 percent (60 percent for piping and 10 percent for insulation), of the total cost of equipment to which piping is connected. The difference between this figure and the 67 percent shown in Table VII is due to minor adjustments which were made in the estimates for process equipment costs. For this plant actual piping costs were substantially the same as estimated costs, the ratio being 0.98.

For plant No. 9, all of the equipment was connected to piping. Here again it was assumed that total process piping (including insulation) would amount to 70 percent of the total cost of equipment. After deducting $50,000 of additional premium time payments authorized by the client to meet necessary schedules, the ratio of actual piping cost to estimated piping cost was 1.03.

For the remaining plants, the ratio of process piping to process equipment is nearer to 50 percent than 70 percent. For these plants, raw material, finished product and some of the process piping was easily visualized and priced separately in accordance with procedures discussed in the first article. For the remainder of the process piping, a factor of 70 percent was used.

Where separate figures are given for piping insulation, it has been assumed that this would average about 10 to 15 percent of total piping costs.

Estimating Factors

The foregoing indicates that it should be possible to develop estimating factors from which relative or percentage costs may be quickly determined in order to preview the preliminary estimates for a proposed plant. These factors, together with the procedures discussed below, are in no way intended to supplant the preparation of the usual preliminary estimates. However, they should help one to form a reasonable judgment on the approximate cost of a plant, several weeks before the preliminary estimate is assembled. Since the sum of the percentage costs for process equipment and process piping shows relatively little variation with the size of plant and the type of process, a suggested procedure for arriving at a quick approximation of cost of a plant is as follows:

1. Study the process or chemical flow sheet and prepare an engineering flow sheet to show each item of equipment.

2. Prepare a preliminary equipment list and price each piece of equipment, as in the first article. This will give the price of the process equipment f.o.b. the factory, with freight allowed to the site.

3. Divide the total so obtained by 0.70 (Table VI) to give the cost of process equipment including foundations, supports and installation.

4. Estimate the total process piping costs from the type of process and the relative costs given in Table V. For solids processing plants, the ratio of process piping to process equipment averaged about 7.4 percent. For solids and fluids processing plants, this factor averaged about 25 percent. For fluids processing plants, this factor averaged about 50 percent, but may run as high as 70 percent for distillation and similar plants. As an approximate check, the cost of the equipment to which piping is connected should be obtained and this total multiplied by 70 percent to give the total cost of process piping.

5. Multiply the sum of the total process equipment and total piping cost by two to give the total cost of the plant in approximate form.

For this procedure, it is not necessary to prepare preliminary plot plans, equipment arrangement drawings, construction schedules, and other information usually assembled in the preparation of preliminary estimates. To obtain an approximate cost, the only prices needed are the material cost for processing equipment.

The distribution of costs among the major subdivisions of construction may be approximated from Table VIII. This table is similar to Tables IV and V, except that all percentage costs have been rounded out and some of these costs have been increased or decreased to make them more nearly identical with relative actual costs. Only three size classifications are given instead of seven as in Table IV, since plants ranging from $1,000,000 to $5,000,000 showed only minor variations in relative costs for the limited data available. Table VIII should not be used for plants costing much less than $500,000.

Conclusions

Before summarizing this study, it should again be emphasized that all conclusions are strictly confined to the size and type of plant considered, and also to the items of work included under each major subdivision of design and construction.

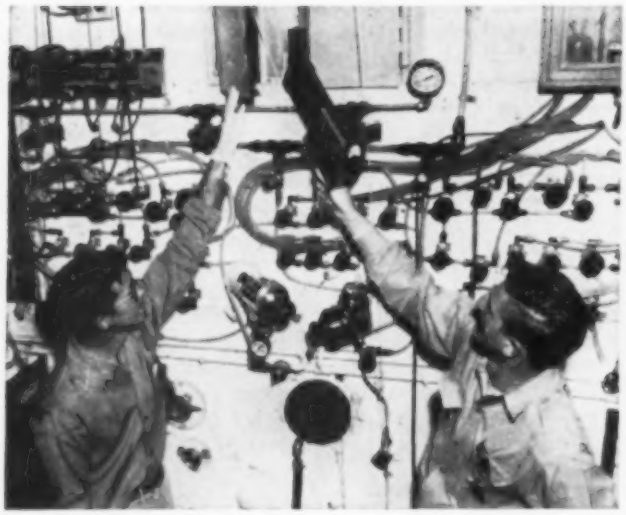
The more important conclusions derived from the analysis given here may be summarized as:

1. Estimated percentage costs reflect actual percentage costs with reasonable accuracy, as is indicated by Table II.

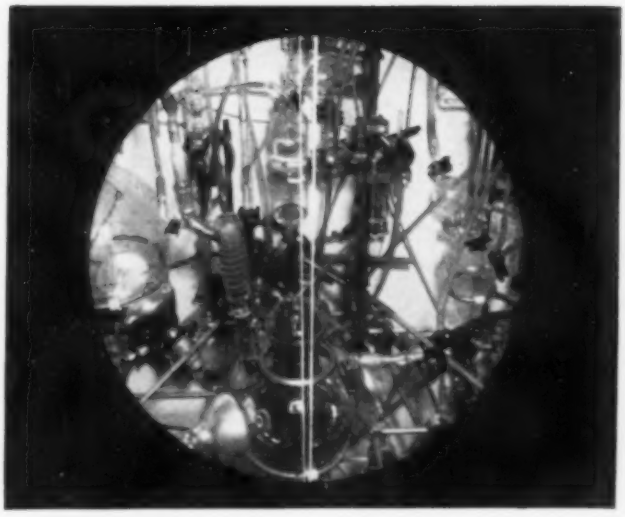
2. Preliminary estimates may give the actual total cost of a plant within plus or minus 10 percent, based on the scope of the work as defined by the estimate. The differences between actual and estimated costs for six plants were only plus 13.7 percent, including changes in scope, and 5.9 percent excluding changes in scope. It is true that the differences were all overruns, rather than underruns, but it is reasonable to expect that after prices and labor costs have become stabilized, underruns will also occur.

3. Percentage costs depend primarily on the size of the plant and the type of process, as indicated by Tables IV and V. The sum of process equipment and process piping costs, however, is substantially independent of these factors and averages about 50 percent of the total cost of the plant.

4. It should be possible to group plants by size and type of process so as to approximate the total cost of a plant and of each major subdivision of construction work by pricing only process equipment material costs. A tentative step in this direction has been made here.



Checking the radiation emitted by fission product materials processed inside a thick walled concrete cell



Periscope view of equipment inside the "hot cell" for chemically processing highly radioactive materials

Engineering and Economics

AN OUTLINE OF SIGNIFICANT FACTORS AND PROBLEMS INVOLVED IN THE COMMERCIAL PRODUCTION OF POWER FROM ATOMIC ENERGY

Engineering of atomic power plants requires a consideration not only of the ordinary properties of construction materials such as corrosion resistance, heat transfer, and thermal expansion but of nuclear properties as well. The author discusses the special problems involved and also covers the economic phases of atomic power engineering.

CONTROLLED release of atomic energy is effected by means of the pile. This is a device wherein the neutrons formed in the fission of uranium-235 are utilized in producing new fissions to form a self-sustaining process. Energy of fission appears as heat. In a sense the atomic pile is not a new method of producing power, as was the steam engine or the gas turbine, rather it is a new kind of furnace.

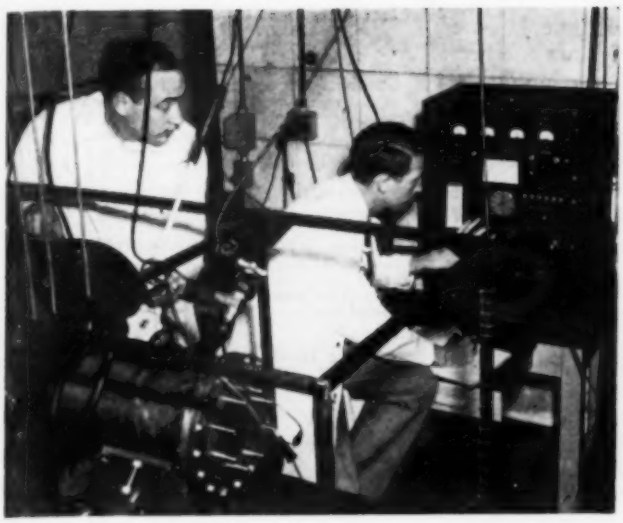
The important action of a natural uranium, graphite moderated pile is the absorption of a neutron by a nucleus of U-235; this can be accomplished if the neutron is moving at the relatively slow speed of approximately one mile per sec. The resulting nucleus is unstable and splits into two fragments with conversion of a small fraction of the matter to energy. One to three fast neutrons are formed and move away at a speed of about 6,000 miles per sec. The two fragments from the nucleus of uranium travel away at approximately the same speed as the fast neutrons, but are quickly slowed down through interaction with the electrons of the surrounding atoms. The latter are violently jostled and vibrate rapidly thus causing the fuel elements of uranium to become hot. Therefore energy released in the fission process appears as heat in the fuel elements.

A somewhat different action occurs in the case of U-238 present in the natural uranium fuel elements, and for thorium, if it is present in the pile. For example, when a neutron, preferably with the resonance velocity of 10 miles per sec., approaches the nucleus of an atom of U-238, it is absorbed to result in an excited nucleus. Over a period of time it gives off beta particles and decays to element 94, plutonium. The latter element is fissionable just as is U-235. In much the same way thorium will absorb neutrons and then decay to an uranium isotope, U-233, which is fissionable.

Production of fissionable isotopes from U-238 and from thorium gives rise to the possibility of regenerating the atomic fuel in a power pile.[1] The value for the number of neutrons produced per fission of each U-235 nucleus, according to the Smyth report[2], lies between 1 and 3. Taking the most optimistic value of 3 and assuming a perfect pile in which no neutrons are lost and wasted, two neutrons become available from each fission after slightly more than one neutron has been used in U-235 fission to keep the process going. Hence, for each atom of U-235 burned up, two new fissionable atoms would be formed in U-238 and thorium and twice as much atomic fuel would be regenerated as would be consumed. This ideal condition will not be achieved but it does illustrate the possibility that power piles may produce as much or even more fuel than they burn.

The attaining of a high neutron economy is, therefore, an important

This is a condensation of a lecture presented at the National War College, Washington, D. C., May 16, 1947.



A beta ray spectrometer determines the energy radiation emitted by a radioactive isotope

A shipment of radioactive iodine in a small glass bottle is placed inside a 2 in. thick lead shield

# of Atomic Power

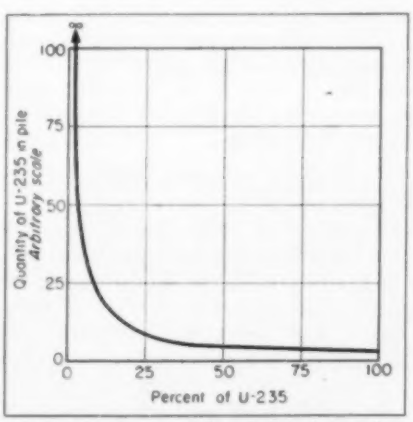
JAMES H. LUM
Executive Director, Monsanto Chemical Co., Clinton Laboratories, Oak Ridge, Tenn.

aspect of pile design. Materials of construction with a low tendency to capture neutrons must be selected and they must be free of impurities having large cross-sections for absorption of neutrons. The design must minimize the escape of neutrons from the pile so that the maximum number will be available for the fission process and for capture by U-238 and thorium.

Engineering Considerations

For the production of power, a pile operating at high temperature is necessary. It might consist of vertical fuel rods in vertical channels through the moderator. A heat transfer medium, gaseous or liquid, would move through the channels and flow past the fuel rods. Hot medium would then pass to a heat exchanger where high pressure steam would be generated to drive a turbo-generator unit. Such an atomic power plant is subject to certain limitations. Efficiency of the heat cycle will depend upon the maximum temperature; removal of the heat will be governed by the normal laws of conduction, convection and radiation; the pile must be larger than the critical size; and there must be heavy shielding to protect workers from radiation.

One of the first items in the design of a pile based upon the fission of U-235 by slow neutrons is the degree of enrichment of the active material. In the curve shown, concentrations of U-235 in the fuel elements of the pile are plotted as abscissas. The ordinates represent, in arbitrary units from 0 to 100, the amounts of U-235 required to reach the critical point where the fission process will be self-sustaining (the critical mass). This value and the concentration of U-235 in the fuel elements will determine approximately the volume of the fuel elements and of the pile itself. From the curve it can be seen that the amount of fissionable material for critical mass decreases markedly as the concentration of U-235 in the fuel elements is increased. At 100 percent enrichment the critical amount will be only a fraction of that needed for natural uranium containing 0.7 percent of U-235. If natural uranium is used for the fuel elements, the volume will be large not only because of the greater critical mass but also because of the dilution factor.



Critical mass is reduced by increasing concentration of U235

As the size of the pile is decreased, through use of enriched fuel the total heat evolution per unit time may not be greatly decreased, so that the B.t.u. released per sq.ft. of surface of the fuel elements will be greater. Severe engineering problems are then encountered in removing this heat effectively so that the temperature will not rise to excessive levels.

Another important technical problem arises from enrichment of the fuel elements in U-235 and is concerned with the responsiveness of the pile to changes in conditions. Assume that in a highly enriched pile, where the fuel elements consist of 98 percent U-235, that some factor controlling the neutron economy changes resulting in an effect similar to that of increasing the U-235 in the pile by 0.1 percent. Immediately, the energy level of the pile will start to rise and will continue to rise indefinitely unless this condition is corrected by movement of the control rods which will introduce a greater amount of some neutron absorbing poison such as cadmium or boron-containing steel. The control rod must correct this condition instantly, otherwise the power will increase by a factor of 3 in one sec. and by 20,000 in ten sec.

Most piles now contemplated involve fuel elements from which the heat release per sq.ft. of surface will be

large. Consequently, even with the most efficient means of heat transfer, the fuel elements will assume very high temperature and must be of refractory materials.

Since heat will be generated uniformly throughout the fuel element and since the transfer medium can only remove heat from the outside surfaces, a gradient in temperature will exist from the outer surface to the center of the fuel element. In certain designs contemplated for power piles these gradients would be quite large so that thermal stresses set up in the fuel rods are a major problem. Rapid heat removal from the fuel element necessitates the maintenance of high coefficients of heat transfer. If the fluid cooling medium is water, it must be purified and practically freed of all dissolved salts so that there will be no tendency for impurities to be deposited upon the heat transfer surfaces.

Material Limitations

Certain limitations and restrictions on materials of construction for the pile are encountered. Obviously, in a power pile operating at high temperatures, materials of construction must have a high melting point. Certain common high melting materials of construction such as steel, copper, and nickel must be eliminated from consideration since they have such high cross sections for neutron capture as shown in Table I.

In any pile based upon the reaction of slow neutrons with U-235, it is necessary to provide a moderator to slow up the fission neutrons which have an initial velocity of about 6,000 miles per sec. when formed. In contrast, a slow neutron has a velocity of about one mile per sec. Elements most efficient in this slowing process are those of low atomic number as listed in Table II.

Choice of moderators is limited as shown by the column of values under "Cross-Section" to the elements deuterium, helium, beryllium, carbon, oxygen, fluorine and perhaps hydrogen. From this list the elements in form of gases can be eliminated as unsuitable. Both hydrogen and deuterium are feasible moderators when combined with oxygen in the form of water and heavy water. On the other hand it would be necessary to construct the pile to withstand the extremely high pressure necessary to keep these moderators from vaporizing at high operating temperatures. Beryllium and beryllium oxide are attractive from the standpoint of low neutron absorption, moderating effect and existence in refractory forms. At this time, however, the technology of beryllium and beryllium oxide is not well developed. Most important moderator to date is graphite which has been used in the Hanford and Clinton Laboratories piles. Graphite could be used at high temperatures as long as reactive gases such as oxygen are excluded from the pile system.

Somewhat the same considerations hold in the selection of the heat transfer medium. This obviously could either be a gaseous or liquid substance. In Table III are listed certain gases which from the standpoint of neutron absorption would be quite satisfactory as heat transfer media. Because of its chemical inertness, the noble gas, helium is attractive. At high temperatures, hydrogen and nitrogen might become reactive, particularly with uranium. From the standpoint of all properties, sodium is one of the most interesting materials for use as a heat transfer medium in piles. Diphenyl oxide, often suggested as a heat transfer medium because of its high boiling point, is similar to most organic compounds in that it would be rapidly decomposed under the intense neutron bombardment in the pile. The same difficulty is encountered when water is bombarded.

Intense radiation, consisting of neutrons and gamma rays from an operating pile, creates numerous problems. In the first place, the pile must be surrounded by adequate shielding so that personnel will be protected. This can take the form of lead or concrete. Entire working mechanisms of the pile must be characterized by simplicity and reliability of design. Duplicate units should be available and construction should be such that units can be lifted out of the pile by remote control for replacement.

Finally, care must be taken in the use of any organic compound such as lubricants, plastics, and electrical insulation, as these materials will all be decomposed in time by the intense radiations from the pile.

Economic Considerations

A study of economic factors in the utilization of atomic energy for the production of power should consider the following important questions: (1) Is there a sufficient world supply of fissionable materials so that if technical and scientific problems are solved, power from atomic energy may be comparable in magnitude to that obtainable from coal or oil reserves? (2) What is the degree of uncertainty in estimates which have been made thus far of the probable cost of power from atomic energy?

A recent report of the Atomic Energy Commission[1] states that thorium and uranium are the two natural sources of nuclear energy in the immediate future. Interest in atomic energy as a source of power will therefore be dependent upon whether the total amount of energy which may be available in the mineable amounts of these two elements is sufficiently large.

Both thorium and uranium are elements of moderate abundance in the earth's crust; they are comparable to lead. They do not occur, however, in well segregated ore bodies as do lead, gold and silver; they occur almost always in low concentrations. Information available prior to 1941 indicates that the then-known "commercial" deposits of uranium contained about 50,000 tons of metal. In this estimate "commercial" was defined as ores containing one percent or more of uranium. Also about one-tenth of this

Table I—Materials of Construction

Material of Construction	Melting Point, Deg. F.	Capture Cross-Section for Slow Neutron, Barns*
Copper	1981	4.3
Nickel	2646	6
Iron	2795	2.1
Beryllium	2462	0.01
Chromium	2939	2.5
Vanadium	3110	5
Silica	3092	0.24
Magnesia	5072	0.31

* 1 barn equals 10^{-24} sq. cm. Values are from published articles and do not represent the most recent values of the A.E.C.

Table II—Materials From Which to Select Moderators

Atomic Number	Element	Capture Cross-Section of Slow Neutrons, Barns	Common Physical Form
1	Hydrogen	0.33	Water
1	Deuterium	0.03	Heavy Water
2	Helium	0.00	Gas
3	Lithium	66.0	Low Melting Solid
4	Beryllium	0.01	Metal
5	Boron	710.0	Refractory Carbide
6	Carbon	0.0048	Graphite
7	Nitrogen	1.2	Gas
8	Oxygen	0.00022	Gas
9	Fluorine	0.01	Gas

Table III—Material From Which to Select Heat Transfer Agents

Gas	Capture Cross-Section for Slow Neutrons, Barns	Melting Point Deg. F.	Chemical Properties
Hydrogen	0.33	...	Somewhat reactive
Helium	0.00	...	Inert
Argon	1.0	..	Inert
Nitrogen	1.2	...	Fairly inert
Oxygen	0.00022	...	Reactive
Fluorine	0.01	...	Reactive
Liquid			
Water	0.66	32	Unstable
Lead	2.8	622	Inert
Sodium	0.4	208	Reactive
Diphenyl	....	...	Unstable

PLUTONIUM PILE NOW OPERATING

Editors Note: Existence of a new type of atomic pile has recently been disclosed by the Atomic Energy Commission. Utilizing plutonium instead of uranium, and operating without a moderator, it is the first pile to employ fast neutrons rather than slow ones. This new pile has been in operation for several months and marks an important step in the commercial development of atomic power. The new pile is essentially an atomic bomb in which the chain reaction is controlled. In contrast to older piles which required tons of natural uranium, the new pile requires only a comparatively few pounds of plutonium. So far it has been run at a rate of only a few hundred watts, but the power level at which it is operated is limited only by the rate at which heat can be carried away.

amount, 5,000 tons, was estimated to be in the U. S.[3] Conversion of the world reserves of uranium, oil, and coal into pounds of uranium on an equivalent energy basis gives the following approximate values—Uranium —10^9 lb.; petroleum—10^7 lb. of equivalent uranium; coal—greater than 10^{11} lb. of equivalent uranium.

From this it appears that the minimum amount of uranium constitutes a significantly large reserve of power and consequently warrants further economic study and technical development. There is an important reservation, however, in this conclusion. The comparison is based upon the assumption that not only U-235 but all of the U-238 can be utilized as atomic fuel. The latter is feasible only if U-238 can be converted to fissionable plutonium. It is not yet known whether the neutron economy of piles will permit this and whether chemical and metallurgical processes can be simplified to make the recovery of plutonium economical. On the other hand, the ultimately workable reserves of uranium may be considerably larger when it becomes technically feasible to work ores leaner than one percent. Thorium appears to be a source of power of similar magnitude to uranium.

Baruch Report

With regard to the cost of atomic power, the Baruch Report[4] is probably the most authoritative study. The principal premises upon which this study is based are as follows: (1) Hanford type pile modified for operation at high temperature, (2) recovery and feeding back of by-product plutonium, (3) size of plant—75,000 kw, (4) load factor—100 percent, (5) interest on investment—3 percent. Apparently the cost of the atomic fuel was considered negligible, and great weight must have been placed upon the possibility of recovering and feeding back fissionable material which could be used to continue the operation of the plant without the purchase of additional fuel.

Principal conclusions of the Baruch report are as follows: (1) Atomic plant —total investment, $25,000,000; investment per kw., $333.; operating cost per kwh., 0.80c.; (2) Coal plant—total investment, $10,000,000; investment per kw., $133.; operating cost per kwh. with coal at $7 per ton, 0.65c.; operating cost with coal at $10. per ton, 0.80c.

An important item in comparing the two plants is the relative size of the investment. The figure of $10,000,000 for the coal-fired plant of 75,000 kw. capacity is, of course, well established from actual practice. On the other hand, the cost of an atomic plant represents an estimate. In arriving at the value of $25,000,000, the following approximate values were taken for the individual components of the complete atomic energy plant: Pile—$12,000,000, chemical and metallurgical plants—$5,000,000, steam plant—$2,000,000, power plant—$6,000,000 to total $25,000,000.

The value of $12,000,000 estimated for the pile itself was based on the Hanford piles and the present pile at Clinton Laboratories. Cost of the chemical plant was based upon a process for recovery of uranium and plutonium. The metallurgical plant was based upon information from operations of the Manhattan Project. Values for the steam plant and power plant were determined from the construction of coal-fired plants of similar capacity. It is likely that the cost of the chemical and metallurgical plants for the power unit of 75,000 kw. capacity could be considerably reduced by setting up a single large unit for the handling of spent slugs from a number of atomic power plants.

A preliminary cost estimate of $27,000,000 has been recently obtained using as a basis an initial design for the Daniels power pile plant. These recent calculations, therefore, give additional assurance that the value of $25,000,000 in the Baruch study may not be too far off from the cost of the first power unit which will be built.

Comparison of the detailed operating costs for the atomic plant and the coal plant in the Baruch report shows no undue optimism in these items. The cost for labor and supervision in the atomic plant is approximately two and one-half times that of the coal plant, which is in line with the greater complexity of the atomic energy plant and the necessity for higher grade supervision. There is a generous allowance for chemicals and utilities required for the operation of the chemical and metallurgical units of the atomic energy plant. Depreciation and maintenance is an important factor in the cost of the atomic plant and a rather conservative procedure was used here in figuring that the useful life of the pile itself would be only four years.

Cost of Fuel

It is only in the cost of fuel that the Baruch report may be optimistic. Recent calculations have led to the following conclusions: (1) The amount of U-235 burned may be extended several fold through partial conversion of U-238 to plutonium, so that the fuel cost in the atomic plant will be only one percent of the total operating cost. (2) If uranium metal can be produced for $3 per pound, a pre-war price, and only U-235 will be burned without regeneration of Pu and U-233, then fuel costs will be 25 percent or 6 percent of the total operating costs, depending upon whether one is pessimistic or optimistic as to how far the depletion of U-235 may proceed before it is necessary to remove and discard the spent fuel rods. This compares to fuel costs in the coal plant that are 55 percent of total operating expenses. The value of 25 percent is probably too pessimistic and fuel costs should be much lower for the atomic plant so that the value of 0.8c. per kwh. of the Baruch study should be realizable.

The assistance of the Research Staff of Clinton Laboratories in the preparation of this article is gratefully acknowledged. Particular thanks are due Dr. M. C. Leverett, Dr. C. R. McCullough, Mr. John Menke and Mr. W. I. Thompson.

References

1. The First Report of the United Nations Atomic Energy Commission to the Security Council, December 31, 1946, p. 26.

2. A General Account of the Development of Methods of Using Atomic Energy for Military Purposes Under the Auspices of the United States Government, 1940-45, by H. D. Smyth, August, 1945, p. 28.

3. Unpublished Report by John R. Menke, Clinton Laboratories.

4. Department of State Publication, No. 2661, June 14-October 14, 1946, p. 125.

EDITORIAL VIEWPOINTS

Sidney D. Kirkpatrick and Staff

FOR DISTINGUISHED SERVICES

We are privileged to announce that Merck & Co., Inc., of Rahway, N. J. is to receive this year's Award for Chemical Engineering Achievement. Chairman Alfred H. White and his committee of fifty-two senior chemical engineering educators have so decided after carefully reviewing the outstanding postwar developments that have resulted from group effort of chemical engineers in many process industries. Their decision was based not alone on Merck's pioneering in the large-scale production of streptomycin and other vital medicinals, but also on its constructive personnel policies and practices in encouraging its chemical engineers to participate broadly in all phases of its growing business and industry.

Presentation of this eighth in the series of biennial awards will be made at a subscription dinner to be held in the Waldorf-Astoria Hotel in New York City on Wednesday, December 3, 1947. Interested members and friends of the chemical engineering profession are invited to share with us and the committee in the pleasure of according this recognition to a group that has contributed such distinguished services to humanity.

FOR MORE REALISTIC DEPRECIATION

To already harassed industrial management the disparity between depreciation charges and current high replacement costs is a matter of grave concern. In the chemical process industries, with short-lived equipment and high obsolescence factors, this is particularly true. Insufficient depreciation charges on fixed assets are holding up replacement and plant expansion programs at a time when all-out productivity is needed to combat the inflationary trend. Present high labor costs have led management to demand more modern, efficient equipment. But the old machinery has first to be written off.

One out of every seven of the companies canvassed in the National Industrial Conference Board's current monthly survey of business practices has established a special reserve to offset higher replacement costs. Some managements are reluctant, however, to establish two sets of accounts, one meeting the requirements of the Internal Revenue Bureau and the other reflecting management's view of the proper depreciation charges. Some concern has been expressed over the restrictions imposed by Section 102 of the tax law on surplus accumulation to meet increased cost of capital replacements.

Basically, the difficulty lies in the rigidity of the present tax laws. Allowances of the Internal Revenue Bureau for depreciation are not liberal enough. Two- and three-shift operations in many plants during the war increased depreciation, but the Treasury, in many cases, made insufficient allowance for this accelerated depreciation. Obsolescence, ever present in the research-minded chemical industries, has likewise been given inadequate consideration.

Ideally, business should be allowed to set its own policy as long as it is consistent and does not change constantly. Since no more than the original cost could be recovered in any event, the government would not in the end lose any tax revenue. If management considered it good business policy, it should be permitted to shorten the period of depreciation. In times like these, moreover, when replacement costs are high, there should be such additional adjustments as tax-free reserves.

As a minimum program, tax laws should be liberalized with respect to depreciation. It should not be necessary for management to parallel the unrealistic depreciation charges allowed by the Internal Revenue Bureau with a second, more down-to-earth estimate. Regulations and individual rulings should be broader and more equitable. More weight should be given to the highly important obsolescence factor, so long neglected.

Able to write off its fixed assets at a rate more in agreement with their economic usefulness, management under such a liberalized tax law could greatly increase productivity by means of efficient machinery in new, modern plants. Incentive would be provided for achievement, increased production and greater earnings. And, let's not forget that sufficient earnings must be made if employees are to keep their jobs.

A MARSHALL PLAN FOR SCIENCE?

Many of our ideals and dreams for a world society of free peoples have been rudely shattered by the lack of progress in reaching an international understanding on atomic energy. But we commend the President's Scientific Research Board for devoting a part of its report on "Science and Public Policy" to the urgent necessity for quickly restoring the free interchange of scientific information that existed between nations prior to the war.

Science, this report points out, "cannot flourish in the midst of a troubled armed truce. For the history of science is a monument to the importance of those cherished freedoms of expression and association which are the cornerstones of democracy; and the international community of scientists is a harbinger of a day when common interests may bring all peoples into closer cooperation."

The United States can and should help in the world-wide development of science. Aid can be given to reconstructing and equipping of scientific laboratories in the shattered universities of Europe and Asia. We can stimulate an increased international flow of science and scientists by sending our own leaders abroad on sponsored

lecture tours and teaching assignments. At the same time we can welcome foreign students who can attend our schools. And we can provide tours for scientific missions that come here under governmental auspices. We have made a start in developing a scientific foreign service as part of the work of our State Department, but more could be accomplished if we had scientific missions of our own at several of our principal embassies.

All we can do to stimulate the free flow of research results into a world pool of scientific knowledge is going to help in restoring healthy economies in Europe and Asia. Such an objective should be an important part of the Marshall plan.

WELCOME "NUCLEONICS"

SHORTLY after the A-bombs were dropped on Hiroshima and Nagasaki we were persuaded to launch and copyright a little mimeographed publication we bravely called "Atomic Engineering." It followed in the wake of "Atomic Power," which made its initial appearance in August, 1945, under the editorship of our colleague, P. W. Swain, of *Power*. A few months later Keith Henney, of *Electronics*, contributed "Nucleonics" to complete this McGraw-Hill trinity of experimental titles. Now all three are combined in a new monthly magazine designed to cover the field of nuclear technology and to provide information on peacetime applications of atomic energy.

Unconventional in size for a technical magazine, it is 5½x8 in., and carries no advertising. The subscription of $15 is tied to the publishers' pledge to plow back into its development any income above out-of-pocket expenses.

We welcome the new *Nucleonics* as a pioneering venture into a field that is certain to grow in size and importance. Chemical engineers, whose wartime achievements helped to make the bomb possible, stand to gain much from the peacetime applications of nuclear technology.

ATOMIC LIFE INSURANCE

AN ORDINARILY routine problem that has taken on headache proportions for personnel men in companies with AEC contracts is the simple matter of life insurance for individual workers. The problem is complicated, not so much because the hazards are new and mysterious, as by the security and secrecy provisions that surround practically every job. As a result an employee, say at Oak Ridge, has not been permitted to tell the insurance company exactly what he is doing nor has the underwriter had any way of knowing whether or not the man is an average risk. So sometimes the application might be turned down while the word gets around that it's because of the hazardous character of the job.

To correct this unfortunate situation the Atomic Energy Commission arranged security clearance for Reuel C. Stratton, supervising chemical engineer of the Travelers Insurance Co., who had been nominated by the Home Office Life Underwriters Assn. to represent its member companies. Colonel Stratton has just completed a study of the chemical engineering hazards in all of the AEC projects, evaluating the insurance data on a basis comparable to that employed by the chemical industry in general. He has set up a code system designating various degrees of hazards and has assigned code numbers to the different jobs.

This greatly simplifies insurance procedure. When an application is received from an individual worker, the underwriter can immediately obtain from AEC the hazard rating of the job, and can decide what to do about the application. Since most workers never get near an atomic pile or a "hot lab," the rating is usually that of a normal risk.

There still remains the lesser problem of what to do about those exceptional jobs where an insurance company quotes high rates or refuses coverage. One solution may be for the government to pay the difference in premiums or provide some sort of governmental insurance. Colonel Stratton holds, however, that this is not likely to prove much of a problem for he expects that the majority of all workers at AEC plants will probably obtain their insurance on a basis quite comparable to that existing in other chemical engineering operations.

Stratton's study should go a long way toward removing the bugaboo that has undoubtedly handicapped AEC and its contracting firms in recruiting badly needed personnel. It merely puts into workable formulas the remarkably favorable operating experiences of the Manhattan District which established over-all safety records far better than those in most manufacturing industries.

RESEARCH HAZARD

GOVERNMENT contracts with industry and with outside institutions involve certain patent complications for which solution is being sought valiantly in Washington. This problem is newly urgent because the Department of Agriculture through its Research and Marketing Administration expects to do part of its work by contract with outside agencies.

Many research groups in the process industries may find a chance to do a mutually helpful job either under the R&M Act or with one of the military agencies. It is to be hoped that some of the federal appropriations can be more effectively spent by such cooperative contracts.

But it will be important that there be a clear understanding and an acceptable arrangement as to what patent rights become public property and what is retained by the cooperating agency. With definitely acceptable contract provisions the risk of patent complications can be reduced to a negligible point. But neglect of detail on this subject is likely to give a very serious result.

TRUMAN SHOULD ACT

THREE specific recommendations have been made to the President by his Scientific Research Board which demand early attention. We hope that Mr. Truman will accept these three as specifically urged on him, viz.:

1. An Interdepartmental Committee for Scientific Research should be created.

2. The Bureau of the Budget should set up a unit for reviewing federal scientific research and development programs.

3. The President should designate a member of the White House staff for scientific liaison.

We believe that an acceptance of these principles will undo any damage that might otherwise have followed from the veto of the Science Foundation Bill.

THE PLANT NOTEBOOK

Theodore R. Olive, ASSOCIATE EDITOR

$50 CASH PRIZE FOR A GOOD IDEA!

Until further notice the editors of *Chemical Engineering* will award $50 cash each month to the author of the best short article received that month and accepted for publication in the Plant Notebook. The winner each month will be announced in the issue of the next month: e.g., the October winner will be announced in November and his article published in December. Judges will be the editors of *Chemical Engineering.* Non-winning articles submitted for this contest will be published if acceptable, in that case being paid for at applicable space rates.

Any reader of *Chemical Engineering,* other than a McGraw-Hill employee, may submit as many entries for this contest as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 300 words, but illustrated if possible. Neither finished drawings nor polished writing are necessary, since only appropriateness, novelty and usefulness of the ideas presented are considered.

Articles may deal with any sort of plant or production "kink" or shortcut that will be of interest to chemical engineers in the process industries. In addition novel means of presenting useful data, as well as new cost-cutting ideas, are acceptable. Address Plant Notebook Editor, *Chemical Engineering,* 330 West 42nd St., New York 18, N. Y.

SEPTEMBER WINNER

A $50 prize will be issued to

FRANK I. STANNARD
Chemical Engineer, Akron, Ohio

For an article concerning a system of coolant storage for process work which handles variable loads with one less vessel. It has been judged winner of our September contest.

This article will appear in our November issue. Watch for it!

August Contest Prize Winner

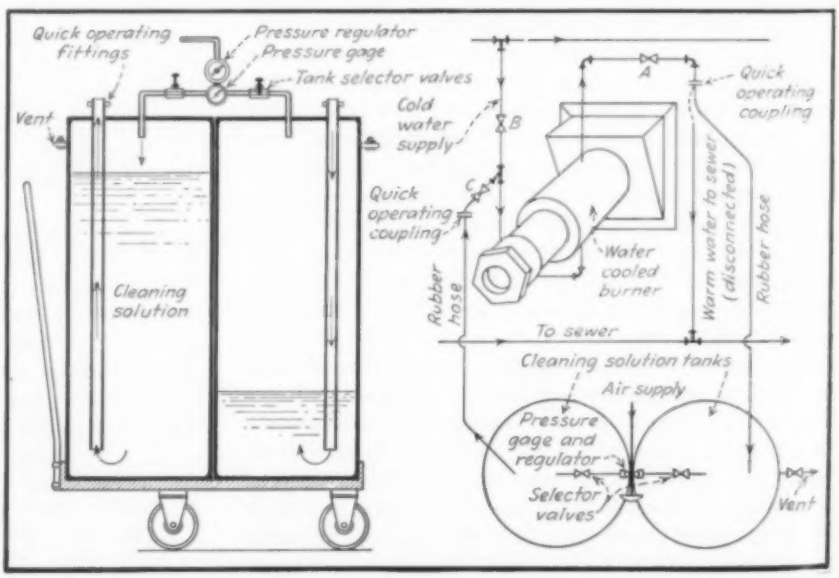
CLEANING DEVICE MAINTAINS WATER-COOLED BURNERS AT MAXIMUM EFFICIENCY

D. E. RICHARDSON and F. C. ARRANCE
Respectively, Plant Engineer and Ceramic Engineer
The Electric Auto-Lite Co., Spark Plug Div.
Fostoria, Ohio

IN MODERN high-temperature furnaces, water-cooled gas burners are often necessary, especially where very high temperatures must be maintained over long periods of time. While water-jacketed gas burners effectively solve the problem of satisfactory burner life at high operating temperatures, they must be properly maintained for best results. If an adequate supply of soft or treated water is available the engineer should experience little trouble with water-cooled burners, but when untreated water is used, as often is the case, scale deposits slowly build up in the burner jacket, cutting down heat transfer and decreasing the flow of water through the cooling system. This condition, of course, is particularly bad where the cooling water is high in lime and other mineral salts. As the scale deposit thickens, heat transfer and water flow are reduced to a point where the burner overheats and failure occurs. Replacement of the burner is expensive and difficult but even more costly is the loss of production which usually results.

It is common practice where water-cooled burners are used to flush the cooling jackets at regular intervals by opening wide the cold water valves leading to each burner. This is helpful but does not remove all the scale which has formed inside the cooling jacket. It is also good practice to have the furnace operator or other personnel check each burner frequently to make certain that sufficient water is flowing through the jacket to cool it properly.

In spite of these precautions, the furnace engineer may find that his burners are running hot and have become so filled with scale that even full line pressure will not force sufficient cooling water through the



1 Dolly-mounted cleaning solution tanks for de-scaling water-cooled gas burners

2 Hook-up of water-cooled burner and cleaning solution tanks, showing piping

jackets. When this condition occurs the cleaning device shown in the accompanying sketches can often be used to remove the scale and save the burner. It has also been found that if this cleaning method is used regularly, formation of excessive scale will be prevented and the useful life of the burners greatly extended.

The burner cleaning equipment consists of two welded steel tanks (Fig. 1) which can be made up in the plant or purchased from any welding shop. The size is not critical and depends upon the application, but 5- to 10-gal. tanks will probably work well in most cases. These tanks can be mounted on a dolly or truck for easy transportation to the burners or in some installations might be centrally located near the burner banks. The cold water supply line to each burner should be provided with a tee, a short nipple and valves as shown on the sketches and both the cold water supply and warm water discharge lines should be made up with quick operating fittings. To clean a burner it is only necessary to connect the rubber hose from the cleaning solution tank to the cold water supply line, close the cold water valve *B* and open cleaning solution valve *C*.

Air pressure then forces the cleaning solution into the cooling jacket of the burner. When the burner jacket has been filled with cleaning solution, valve *A* can be closed to hold the solution in the burner and allow it to become heated, or the cleaning solution can be pumped through the jacket under pressure back into the other tank through the rubber hose which connects the warm water outlet to the second cleaning tank. When the cleaning solution has been pumped from one cleaning tank to the other, it is only necessary to switch the rubber hose connections and change the tank selector valves to reverse the solution flow. The tank vents, of course, should be open when a tank is receiving solution and closed when pumping solution.

If a burner jacket is filled with cleaning solution and this charge of solution is held in the burner and allowed to "cook" for a while and then run into the sewer, little scale will be carried back into the cleaning solution tanks when the solution is pumped through the jacket and back into the tanks. However, if an excessive amount of scale is returned it may be desirable to install screens and check valves in the solution lines which will screen outgoing solutions and allow the returning solution to bypass the screens.

The type of cleaning solution which will be most effective can best be determined by experimentation, but a can or two of "Sani-flush" or similar compound, to each 5 gal. of water, is cheap and effective in most cases. Usually only enough air pressure to pump the cleaning solution into the burner jacket is required, but in the case of badly clogged water jackets forcing the solution in under high pressure is more effective. Care should be taken, of course, not to exceed the safe pressure ratings for the burner and cleaning equipment.

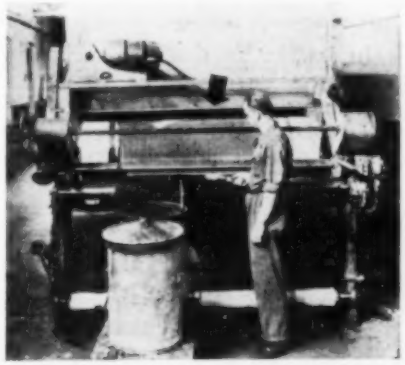
Scale model with counterweighed "floors" aids equipment layout for a multi-story plant consisting of four floors and basement

SCALE MODEL HELPS IN PROCESS PLANNING

IN ITS June 1947 issue *Factory Management and Maintenance* describes an interesting variation of the idea of using models for process layout planning. American Tissue Mills, Holyoke, Mass., had the problem of laying out equipment for a plant of five stories, including four floors and a full basement. Since vertical handling was one of the most important phases of the problem to be studied, it was concluded that any model used should not only facilitate equipment rearrangement on the various floors, but should make it possible to see the elements of adjacent floors in proper relation to one another.

The completed model, which was built to a scale of ¼ in. to the foot, is shown in an accompanying view. Its most novel feature is that the "roof" and the several "floors" are built in the form of trays, suspended by counterweights and capable of vertical movement, individually or together. This solved the problem of equipment rearrangement since one man, standing on either side of the model, can raise or lower any floor with ease. The second problem, that of viewing the several floors in relation to each other, was solved by using a transparent plastic sheeting for the floors.

The office, actually in an adjoining



NO STATIC HAZARD HERE

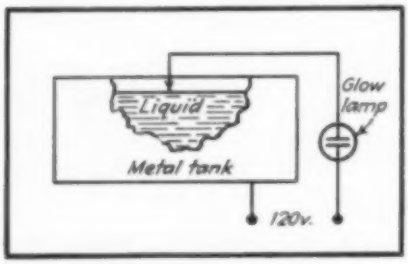
A development in static electricity elimination described in this magazine in February 1946 has been applied in a novel way to do away with one source of fire hazard in plastic coating operations of the Panasote Co., Passaic, N. J. The static-dissipating device indicated by the arrow in the accompanying view is the Ionotron put out by U. S. Radium Corp., New York. This is a shielded bar supporting a strip of radio-active alloy, installed at a point on the machine where static charges tend to build up. The alpha rays from the radio-active source ionize the air at this point, which then acts as a conductor to draw off the charges harmlessly as they are formed.

building, is portrayed in the small cabinet shown at the end of the structure, with floors arranged as drawers to facilitate viewing and arranging. Scale models of all equipment and furniture are constructed from balsa wood. Numbers on the models and a numerically indexed book containing photographs of the actual equipment, assist in visualization and in keeping the record straight.

USING NEON GLOW LAMP FOR LEVEL INDICATION

PAUL C. ZIEMKE
Safety Engineer
Oak Ridge, Tenn.

SHOWN HERE is a diagram indicative of how the simple and long-lasting little neon glow lamp (which draws only 5 watts) can be used to good purpose in checking on the conductivity of liquids, or on their level.



Glow lamp wired for liquid level or conductivity indication

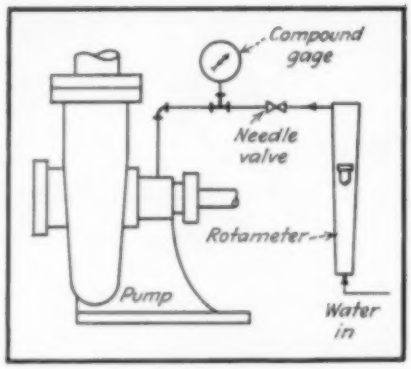
In practice the tank is connected to the neutral bus of the a.c. circuit and the lamp socket is wired in the "hot" or energized leg of the circuit. If desired a 2-amp. miniature cartridge-size fuse can be added as a final refinement.

IMPROVING CENTRIFUGAL PUMP SEALING

GEORGE MAYURNIK
Chemical Engineer, Heyden Chemical Corp.
Princeton, N. J.

WE HAD the problem of maintaining a 3,600 r.p.m. centrifugal pump tight while operating at exceedingly high vacuums. A water seal to the stuffing box of the pump was found unsatisfactory because, invariably, either too much water or air leaked into our system. The pump packing had to be replaced very often because the operators tended to tighten up on the packing gland to make sure that the stuffing box was tight.

The problem was solved by installing a compound gage (pressure-vacuum), a needle valve, and a small rotameter in the water-seal line, as in the sketch. The needle valve was adjusted for a minimum flow of water. The packing gland was tightened up only to the point where a slight pressure reading existed. As long as a positive water pressure existed at the lantern ring, no air could possibly leak in through the stuffing box.



Compound gage, needle valve and rotameter enable sealing water flow to be adjusted for best pump performance

Packing replacements were reduced considerably since the packing gland was never tightened more than was necessary. The operators could at all times readily check the operation of the pump by noting the compound gage and the rotameter readings.

SAMPLING RESINS UNDER HIGH VACUUM

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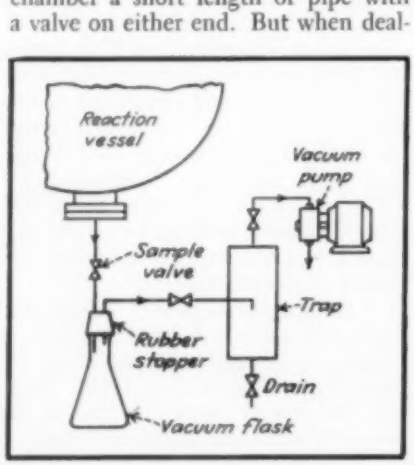
A NEW METHOD of sampling was developed that permitted the removal of samples of viscous resins (25 poises) from reaction vessels under a high vacuum of 20 to 25 in. Hg when the standard method of sampling failed to work properly. With low-viscosity resins a simple and satisfactory arrangement used as a sample chamber a short length of pipe with a valve on either end. But when dealing with viscous materials, a higher vacuum had to be applied to the sample chamber than that on the reaction vessel to permit the viscous material to flow into the sample container. The accompanying diagram shows the arrangement used. A 1/20-hp. electric motor, with a small-capacity sliding vane vacuum pump attached to the motor frame, was found to be small, compact, and thoroughly satisfactory for this use. A trap was used to prevent the resinous material from being sucked into and contaminating the pump.



Vacuum sampler for withdrawing viscous resin samples from evacuated vessels

AVOIDING OVERHEATING IN A FLUIDIZED BED

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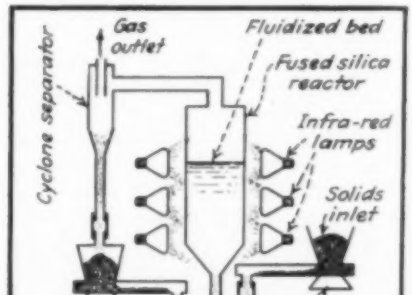
WHEN the fluid catalyst process is adapted to special solid-gas reactions, the solid often crusts on the walls of the reactor, necessitating frequent shutdowns. This occurs because, in maintaining the fluid bed at a temperature slightly below the fusion point of the solid powder, it is necessary to heat the wall temperature high enough to conduct a portion of the heat through the usually postulated gas film. In cases where the wall temperature is above the fusion point of the solid, crusting occurs on the wall.



Infra-red heating through fused silica walls prevents crusting on reactor

A reactor made of fused silica is shown in the accompanying sketch, with heat supplied to the powder by infra-red rays. Since any given solid particle is exposed only momentarily to these rays, and then jiggles into the fluidized mass, an even reaction temperature is maintained with no local overheating and, therefore, no crusting.

In Scaling-Up Operations, Here's How To . . .

1. Set up a plan to unify and correlate the entire development.
2. Marshal and use the best available information on technology.
3. Make decisions count in cost cutting and process improvement.
4. Secure suggestions and utilize them to effect best results.
5. Avoid making mistakes that have already been made by others.

Going To Full Scale With Fewest Headaches

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EVERY commercial process has been scaled-up either deliberately or inadvertently. The phrase "good, bad, or indifferent" describes the various types of scale-up ranging from the pleasing case where smooth and rapid progress is made to the extreme case where many delays and process difficulties are encountered. Well-planned and executed scale-ups have been carried out so that the completed plant runs without trouble and meets all product and cost expectations. On the other hand, processes evolved by a hit-or-miss procedure present examples of unnecessary expenditures of time, money and effort. The whole matter of scale-up procedure is one that deserves the most careful attention, because of the great bearing that the type of process, equipment and plant have on product cost and, in turn, on future competitive position.

The expansion of a chemical process from the test-tube stage to pilot plant and, in turn, to full operation is a major responsibility for those engaged in research and development. Casual statements about the difficulty of seeing where science and development end and practical results begin overlook the skilled effort involved in producing these results. Where there are not many process steps involved and design can be based on well-established chemical engineering operations, such as filtration or distillation, it is usually a relatively simple matter to carry out a successful scale-up from laboratory results through pilot-plant units to full production. In this case, experienced engineers can proceed in logical fashion and may by-pass the pilot plant entirely. More complicated processes, particularly those embodying untried principles or equipment, require experience and above average know-how on the part of those in charge in order to achieve full success. The amount of additional experimental word needed to attain smooth process operation after the plant start-up is determined by the skill and soundness of the scale-up technology. In the case that chances are taken (where untried principles are incorporated in the process) and a reasonably satisfactory operation ensues, it is incorrect to attribute the result to good judgment rather than to luck. An occasion of emergency sometimes involves the use of the "calculated chance," but this should be recognized for what it is. Success achieved on a shaky scale-up may encourage undue boldness the next time; this can result in really great difficulties. On the other hand, an expensive experience may be followed by a period of ultra-conservative policy, with the possible unfortunate result of interfering with the use of desirable new cost-saving procedures.

Present high construction costs emphasize the need for developing and installing efficient low-cost processes. This high expense brings a new concept to the importance of scale-up technology. High costs show the necessity of not expanding in a routine manner. They present a challenge to

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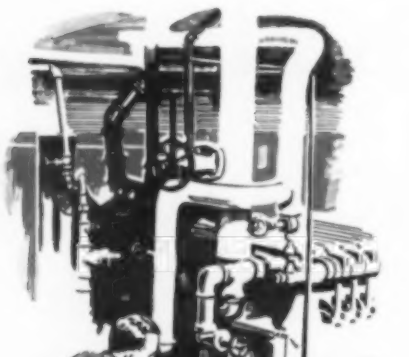
use the best technical and managerial skill in order to plan and execute the scale-up so that it will be based on more than usual economies in construction and process. High costs require that the scale-up take place with a minimum of delay and trouble. Low-cost processes engineered to operate smoothly provide the cornerstone for future profits.

It should be recognized that the subject of successful scale-up is much broader than that of merely achieving full plant operation. While it is naturally desired to avoid the many pitfalls that can interfere with the achievement of satisfactory scale-ups,



the basic objective is to arrive quickly at the goal of the lowest cost process which will turn out high quality product with minimum investment. This means to take advantage of every opportunity for doing the over-all job in the best way. Examples from the past of simple mistakes in which plants have been built at locations where the water supply was unusable or inadequate are rarely heard of today. Instances of more recent difficulties may be due to many different causes; often more than one is in effect. Perhaps too large a scale-up to full plant is attempted and, at the same time, a key piece of equipment fails to function as intended. This combination results in a complicated situation expensive to correct. Focusing too early on one line of process development to the exclusion of others may prevent recognition of the effect that process changes have on product quality. In this case, the full potential of the product may not be reached and time will be lost in starting over again. Changes made between pilot and full plant operation in a process based on an unduly complicated series of steps may result in an expensive puzzle. Such difficulties may be occasioned by lack of planning, errors, or inexperience in scale-up work. The expenditure of additional time and money in such cases generally serves to get the operation working and further investment can then be made to bring down operating cost. However, this cost, as well as that incurred by the delay, remains to burden future operation.

Preliminaries

As soon as it is evident that a possible product and a process for making it are emerging from laboratory results, it is in order to develop data on product characteristics. A preliminary market appraisal should be accompanied by cost studies to determine economic justification for proceeding with a scale-up program.

In these preliminary studies there will be problems which will require for their solution library and paper investigation, laboratory operations and pilot plant work.

The library and paper investigations will seek to show that the field is not dominated by patents, that the process is technologically possible, that the product has merit and that the process is economically feasible in that the product can be made and sold at a profit. Very simple flow diagrams will also be prepared.

Laboratory operations will demonstrate the essential operations of the process, investigate possible alternative routes, select one method, on the basis of obtaining a profitably saleable product, for larger scale attention, and aim toward pilot-plant design, answering necessary questions.

Pilot-plant work will confirm feasibility of essential operations, result in firm choice for expansion (This may in some cases come only after the second scale-up.), develop information for full-plant design and operation, and prepare product for evaluation.

A preliminary feasibility study has been described in the literature[1]. This outline, as well as a pertinent reference on process development, should be reviewed and used by those who make the preliminary investigation[2]. A new product with markedly different properties than materials now on the market is usually considered to be more attractive than current products and a potential low-cost process to be of more interest than established processes.

When these preliminary findings are favorable and indicate that the point of advancing to scale-up may be near at hand, it is suggested that this five-fold program be followed:

Five-Fold Program

1. *Establish an over-all plan so that the whole development can be carried out in logical, integrated order. Policy is set up so that all component steps are considered in relation to each other and so that a basis is provided for proper continuity.*

2. *Study and use the available information on scale-up technology. Assemble the best knowledge available within the organization and in the literature for use throughout the scale-up.*

3. *Recognize the various degrees of freedom that exist in scale-up technology as opportunities for achieving the best results. The decisions and choices that arise during the scale-up should be made so as to obtain the most economical and successful processes.*

4. *Look for and take advantage of available suggestions for carrying out the scale-up in the best manner.*

5. *Avoid mistakes encountered in past experience.*

1. Establish Over-All Plan

An effective scale-up is the result of a well-planned and well-executed effort. A comprehensive viewpoint which includes all phases of the development both at the beginning and during the course of the investigation should be the basis of the plan. As advancement is made from step to step the relation that each phase has to the next one is kept in mind and time is taken to think about the significance and meaning of the data developed and how they bear on the next move. Usually there is considerable leeway in deciding the problem phases to be solved at the various stages of the scale-up. Advantage can be taken of this freedom in longer scale planning. A full listing of the many factors dealing with scale-up technology, plant design and organization responsibilities is given by Vilbrandt[3].

Types of Scale-Up

In making out a plan, it will be well to consider the different types of scale-up that exist. Most scale-ups vary from each other so that a different plan is needed for each one. The following principal types of scale-up are encountered: (1) Adding more capacity for an established product in

which the present process will be used. Minor changes in procedure may be made. The degree of increase determines whether or not this will be handled as a scale-up or only as a duplication of existing facilities. (2) Building a new plant to make an established product based in large part on the present process, but with several significant departures from present practice. (3) A new plant to make an old product by a new procedure. (4) A new plant to make a new product by an established procedure. (5) A new plant to make a new product by a new procedure.

The most complicated case may appear at first glance to be where a new process is worked out to make a new product. To alert management this, however, will present the maximum opportunity as a result of greater freedom of choice. Points in common exist for all scale-ups with many places for skillful thinking and planning.

Work Sheet

The preparation of a work sheet covering the principal questions that will come up in connection with a large scale development should be useful to those working in this field. This aids in the establishment of a definite policy which can be used to advantage in anticipating future questions. The work sheet should help straight-forward progress in systematic steps by insuring that the most important thing is done first. Means for picking out facts from assumptions should be sought, after which planning should seek to find where assumptions can be better replaced by the development of sound data.

In organizing such a work sheet such pertinent features for the entire scale-up should be considered as the economic justification for the program, the building and operating of the pilot plant to secure data, the boundaries and responsibilities of the various groups involved in the scale-up, and finally the design, building and starting-up of the final plant.

In justifying the program economically, a market for the product must be recognized and an estimate of that market made. Is the market large or small, competitive or non-competitive? A preliminary estimate of plant and manufacturing costs should be made, and the stake in the project determined. To guide research and to indicate places where consideration should be given to dropping the investigation, the stake should be re-estimated periodically.

Pilot Plant

Questions arising about the building of the pilot plant include: Is the pilot plant necessary? On what scale should it be? Who designs and builds it? Where will it be located? When should it be built? And who operates the pilot plant?

Process, product and operating information, as well as design data, are required from the pilot plant. Essential features of component parts of the process are worked out in the pilot plant. Flow diagrams, material balances and raw material specifications are established. Special equipment is developed as needed. Unanswered questions are referred to the laboratory. The pilot plant produces material for quality and market evaluation.

Operating information collected in the pilot plant includes determination of yields, analytical and operating control methods, labor requirements, maintenance problems, process hazards and effluent disposal.

Design data for the full plant is likewise obtained in the pilot plant. The sequence of steps; handling of materials; materials of construction; capacities and cycles; power, process steam and water requirements; building requirements; and construction and operating cost estimates are all determined.

The part that the research, engineering, sales, construction and operating groups are to play in the scale-up must be established. Boundaries and responsibilities should be defined. Reference should be made to a literature discussion of this point.[4]

In the design, building and starting-up of the final plant the problems that arise include location, time schedule, flow diagrams, design and layout of building and equipment, plant construction and industrial operation.

Benefits of good thinking and planning at an early stage are great and

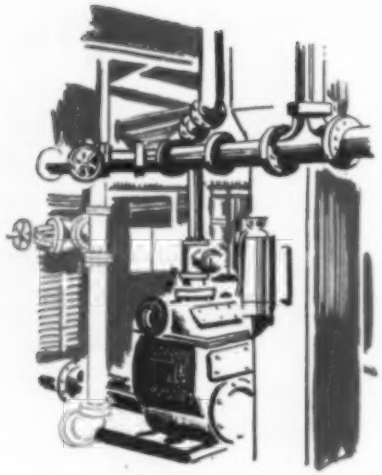
can be emphasized by reference to the less desirable scheme of quickly proceeding along what appears to be the indicated line without taking time to think of the alternatives. Pre-laboratory evaluations of processes can be very helpful in saving expense and can significantly guide research and development. This is discussed in more detail in a recent article.[5]

To summarize, the recommended steps for consideration in planning are: list all the phases to be handled during scale-up, make a work sheet to use as a guide for over-all planning and continual checking, establish the duties of the different groups engaged in the scale-up, plan to coordinate working of the groups, and make an over-all time schedule at the beginning. This time schedule will need frequent revision, but it provides a basis for progress.

2. Use Available Literature

A review of the textbooks and articles dealing with the various phases of scale-up technology will be of great value to those working in the field. Greater benefit will be obtained by repeating the study from time to time. Some of the excellent material available on scale-up technology and pilot plant operation is listed at the end of this report. Those starting initial efforts can perhaps profitably study this literature as a class group. This will make it possible to contribute the experience of the organization as further background.

The points referred to in the outline of pertinent features of scale-up given above have received detailed dis-



cussion in the literature. The development of the design project, flow diagrams, preconstruction cost accounting, project analysis, plant location and design, chemical process principles, and other pertinent data are discussed[2, 5, 6, 7]. In addition to presenting established principles, new points of view are given which may relate to scale-ups now in progress. It appears to be a safe assumption that some working in this field are not familiar with the recommendation of one authority to make a preliminary study of full plant location and accompanying details before building a pilot plant[2]. Methods for making expansion decisions by a pattern system have been presented[3]. The important bearing that market research has on scale-up is receiving increasing attention in the literature[9, 10]. Recent pertinent articles are listed in the references[11, 12, 13].

The function, design, construction and operation of the pilot plant are reviewed in detail[14, 15, 16]. It is essential to know the purpose and the various data and information desired from the pilot plant[17, 18, 19]. Additional discussion concerning semiworks uses is available[20, 21, 22, 23]. All of these articles should be the subject of careful review and study for those connected with pilot-plant work. Safety is an important consideration in scale-up work[8, 24].

3. Make Decisions Count

Decisions that must be made during the scale-up afford opportunities to achieve the best possible process, product and plant. While the needed decisions will be made according to the best judgment of those concerned, it is possible to go beyond this point by giving particular study to the key decisions. Some of the many choices will appear as urgent matters to be handled promptly unless steps are taken to anticipate them. It is imperative to realize the important role that wise selection bears on the final score of the scale-up. Time should be taken to make sure that all pertinent data are available and that full use is made of them.

Assumptions or calculations dealing with product merit, process feasibility and investment or operating cost must continuously balance current data against the likelihood of future developments. Thus, the product's major uses may be found in other fields than those now expected or new process possibilities may develop that will bring about marked improvement in product properties. Costs of manufacture decrease in many cases after operation has reached a high level. Judgment based on experience is required to reach the best decision after all the facts are at hand. It is the rare case where all needed information can be made available to give the exact market and cost picture that lies ahead.

Key Decisions

Some of the key decisions are reviewed in the following paragraphs. Specific answers usually apply to one particular job, but certain principles apply to all scale-up phases. This discussion is not presented to generalize for all cases, but rather to emphasize the opportunities that do exist for selection.

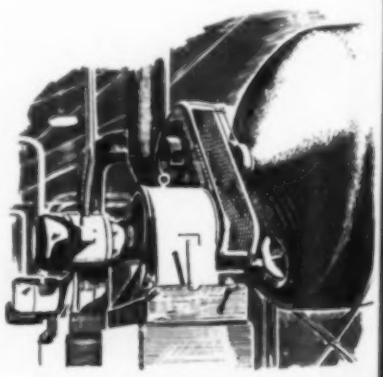
Determining the right time for scale-up is the first important decision that comes up. The best balance should be sought between proceeding rapidly to save time and working more slowly in order to obtain comprehensive data that will firmly substantiate the wisdom of going ahead. Too long an interval in the laboratory results in a loss of production profits, but authorization for the considerable expenditure of money required demands an adequate and sound basis for proceeding. It is easy to become overly excited with very encouraging preliminary data. Such data sometimes overcome the normal conservatism that underlies a policy of obtaining as many facts as possible. When favorable results of this type are obtained, it is well to use them as an incentive to obtain full data rather than to start immediately to scale-up.

In some instances a better comparison of two processes can be accomplished more quickly on paper than can be made by operating them. The making of a paper study where a process does not exist serves to indicate where experimental effort can best be directed[3]. Careful study to locate possible additional lines of investigation dealing with the proposed project should be sought at an early date. Such data may bear importantly on determining the best point to scale-up.

Information will be learned more rapidly by large-scale investigation, such as pilot-plant operation, than can be developed by continuing with small tests. For this reason, a courageous organization has much to win by putting its money behind an expansion at an early date, particularly if those who are experienced and closely connected with the project are willing to judge it as having good chances for coming to a successful conclusion.

Several types of scale-up, such as making a known product by a new process, a new product by an established process, or a new product by a new process, have points of difference with regard to scale-up time. If the product is one that is already on the market, the reasons for going ahead will usually be based on such considerations as plant location, market proximity, tie-ins with existing plants, or the use of an improved process. Perhaps more than one advantage will be present. Deciding when to scale-up in this case is largely determined by reaching the point of having a process that works, a favorable market forecast and an attractive cost analysis. If no evaluation of the product is needed (because its merits are already known), the timing will depend on the technical state of the process together with construction costs. It appears wise to scale-up as soon as economic and market studies indicate that the new investment is justified.

In the case of a new product to be made in existing types of equipment, first emphasis will normally be placed on finding the sales possibilities of the product. When market and cost studies indicate that the proposed product is worthwhile, it is in order



to consider plant construction. Whether or not existing equipment will be used for making the new product will largely govern the necessity and type of intermediate pilot-plant investigation.

New Product by New Process

In going to a new product made by a new process, a larger investment and perhaps chance may be involved which make it highly essential that well-based conviction about product sales potential and process merit are present. The point at which the laboratory results for a process to make a new product are sufficiently advanced so that a scale-up to pilot plant can be considered is connected with the sales possibilities of the product. Market evaluation is, therefore, an important feature. In many cases it will be considered necessary to erect a pilot plant in order to produce material for broader evaluation. The guiding thought is to develop a conviction that there is merit in the product and process based on experienced comparisons with other products and processes. The decision of advancing to semiworks will also rest on the presence of favorable economic studies. If an existing pilot plant can be used, it is easier to decide to make some poundage of material for evaluation than when a new pilot plant must be built. It is necessary that sufficient details should be available in laboratory results, as described below, to establish the elements of the process.

Real Components

The essential features of the process should be demonstrated before leaving the laboratory. The rule of making mistakes on a small scale is important to follow in this connection. Plenty of opportunity should be taken to introduce wide variables at this stage of the investigation. It will not be possible or desirable to decide the best or cheapest methods for carrying out each phase of the process as that will be done in the pilot plant. What is needed will be the real component parts. Changes in process cannot be handled as readily and flexibly in larger scale operation, and for this reason it is profitable to perfect such phases on a small scale. Here again will be a place for experience to balance between determining full detail and making due speed in getting the product on the market. It is more than likely that new process alternatives will be found in the pilot plant; this is desirable. The question of whether further laboratory work on the new alternatives is needed can be decided at that time.

An important point in this connection is the fact that after certain preliminary information is developed, further data can be found best by attempting to make larger amounts of product. Thus, it may be possible to make a few pounds of material on a small scale and appear quite successful, but if it is desired to know what some of the "bugs" are, try to make 50 lb. under the same conditions. More will be learned in so doing than in spending more time with smaller samples. Any "bugs" will point the way to further small-scale experiments.

Uniformity

After the essential features of the process are demonstrated, laboratory operation should attain a sufficiently uniform basis so that results can be consistently duplicated from day to day, from unit to unit, and from operator to operator. When this point has been reached, it will be correct to expand to the pilot plant. Uniformity of operation is required to provide adequate product and process data. Uniformity means just that. If the process is not under control at this stage, it will certainly give difficulty on the large scale.

It is not always realized that a process that works intermittently on a small scale with variable quality and changing production rates cannot be immediately increased in scale and operated at a 100 percent output rate. The trouble comes from the thought "Simply do in the same way on the larger scale what you are doing now."

Small-scale testing involves variables that are continuously being changed, perhaps almost intuitively. The phrase "scaling-up as soon as a process is apparent" means that the things known about the laboratory process and product have been evaluated and appear favorable, and larger scale information is now needed.

It is important to give consideration to more than one possible process in order to achieve the best plant. The objective of the best and most simple process must be kept in the forefront. When a process first develops from the initial laboratory results, it appears to be the natural thing to continue with it as the logical point of follow-up. However, opportunities will usually be present for selecting different methods to follow for some process phases. It is quite likely that the possibility of more than one process may appear. It is then profitable to evaluate these fully in order to look toward the objective of the most economical plant[8].

The point is emphasized that if the alternative possibilities do not appear, a direct effort should be made to locate them at an early point in the scale-up. This should go beyond giving consideration to the permutations of the present proposed process; radical changes in concept should be sought. People with quite different viewpoints and backgrounds should be consulted. Their suggestions may not sound feasible at first, but further investigation often reveals their merit. Searches

for different opinions and references to other processes and industries will be helpful. The decision to search for alternative processes is not one that forces itself; it must be sought.

Pilot Plant Size

The purpose of the pilot plant sets its scale. The principal objectives are to perfect and obtain data on the laboratory process, to obtain product for test and evaluation, and to select and develop the equipment for full plant operation. Variations in the relative importance of these several objectives for different scale-ups will have to be taken into careful account in arriving at the best proportions. If it is not necessary to make large amounts of material for evaluation, the size of equipment to carry out process steps that are already standardized can be quite small. Thus, there will be several units in most pilot-plant operations. Each one of these can be scaled to the smallest size that will give the needed information. A routine step, such as a

chlorinator, may be on a small scale, while an operation that has not been done previously will be designed for a larger rate.

In cases of new products based on new processes, the pilot plant should preferably be large enough to produce an amount of product somewhere in the range of at least 10 to 50 lb. an hr. for materials which are expected to have significantly large-volume output.

Kinks Show Up

It is generally held that the larger the pilot plant, the smaller will be the risk involved in going to full manufacture. Many feel that the increased cost occasioned by a bigger pilot plant is saved in the over-all expenditure. Process kinks show up in medium-sized pilot-plant operation that have not appeared previously. Opportunity is then given to work out the details necessary to perfect the process. It cannot be emphasized too strongly that the leading purpose of the pilot plant is to reduce final plant investment and operating cost with all the many factors that this includes.

In establishing the scale of operation of the pilot plant, it is well to keep in mind the possible ranges in capacity that may be desired for the full plant. This provides a chance to maintain a reasonable ratio in the final scale-up. In selecting the pilot-plant size and in determining the amount of scale-up to full plant, it should be remembered that the pilot plant will very likely continue in use after commercial operation starts. A sufficiently large semiworks will be very useful in testing projected process changes at a later date. A pilot plant that is too small will have limited value for this purpose.

The amount of scale-up made in going to full plant should be on a carefully planned basis where all available facts are brought to bear. A rough rule of using a 20-time scale-up is a good starting point. It is easily recognized that the use of new procedures calls for more caution than does the installation of familiar process steps. If the large-scale operations are based on handling materials of known properties by normal chemical engineering processes, such as mixing, drying, distillation, etc., there is less chance than when untried procedures are utilized. Ratios in the order of 100 to 1 are sometimes used by experienced development engineers along the lines of well-established operations. When new principles are employed, the degree of success is determined by the skill and forethought used; luck may play a part, but counting on it results in headaches.

If one unit has been developed that works satisfactorily and the scale-up merely involves duplication of this equipment by building a large series of similar units, the problem involved is greatly different from that encountered in increasing the size of a reactor or changing from batch to continuous operation. The fact that in chemical vessels the volume increases as the cube of the size, but in cooling jackets only as the square of the size, means that heats of reaction may cause quite different effects in large units than in small ones.

Intermediate Step

If a single unit has been thoroughly tested, it can be duplicated without trouble. However, experience has shown that for plants where several hundred or more additional units are to be installed, it is highly desirable to first expand to six or ten units and operate them together as the first step. Even in this case, an intermediate step of 50 units or so is often considered worthwhile. Pieces of equipment auxiliary to the individual units are frequently used, in which case care should be taken to insure that the expansion will not change their function.

It has been said that full-scale operation will really work out the "bugs." It certainly will show them up if they are there. The most desirable and economical thing is to get the "bugs" out at an intermediate process stage. This is a guiding thought in thinking about scaling-up to full plant. Are we set up to have a smooth running operation?

In scaling-up a process from the pilot plant to full operation, there are two methods of assigning the responsibility for starting-up the plant. In the first method, the technical group is made strictly responsible for the plant performance until a reasonable degree of routine production is under way. The operating personnel assists in handling materials, in safety and in repairs. This method has merit when adopted as a general policy because technical people realize the importance of their preliminary work in this case and see that the "bugs" must be essentially ironed out in the laboratory and pilot plant. They have enthusiasm for getting the process working and carry a certain momentum into the plant start-up. If a stated product purity or yield is claimed for a new process, it is worthwhile for these figures to be demonstrated by the technical group. Doing this sets a standard for future operation.

The second method of plant start-up is to make the operating people entirely responsible, but with the technical group available for constant assistance. This method is generally used and means that the process must stand up early in the game under the practical handling of plant personnel. It is essential in this case that the plant people who are going to operate the process should become familiar with the pilot-scale operation.

Several executives who have had experience with both methods favor the first of the two described. Technical and operating groups must work closely together in either case. Particular care should be taken to have it thoroughly understood exactly who is in charge; responsibility should be clearly designated at the time of start-up as to whether the technical or operating people are running the process.

4. Heed Suggestions

The following paragraphs present some suggestions for the scale-up.

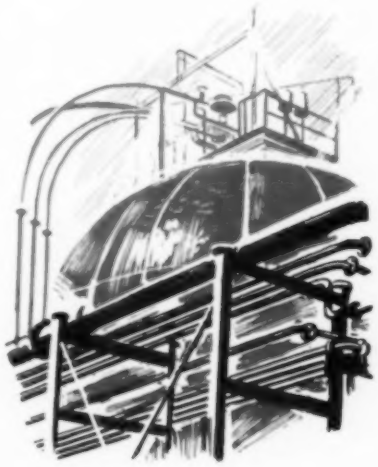
Significant advantages are obtained when chemists and engineers work together in intimate fashion from the beginning of a development. The statement is sometimes heard that the chemist will perfect the laboratory process and that the chemical and mechanical engineers will then design and build the pilot plant. This view has proved valid for many cases, but it has its limitations because the philosophy of "Now the engineers will take over" or "Now the laboratory men have performed their full function" can hinder full cooperation.

Chemists and engineers can work together well as a team in the early stages of scale-up work. A lack of skill-

ful chemical and mechanical engineering at early points is a handicap. There should not be any arbitrary separation of the two classes of workers after the test-tube experiments are passed; chemists can be helpful during later stages. The important thing is that chemists do not try to do engineers' work and vice versa.

If a filtration step is to be introduced, a well-trained engineer is in the best position to design or select the equipment. The engineers must fully understand the underlying principles of the proposed process. When missing facts are noted, it is important to go back to the laboratory for needed information.

Over-all responsibility should be given to one individual so that there will be neither overlapping of functions nor a gap between people with



different duties. This man must take the necessary steps to maintain coordination.

This subject can perhaps be illustrated by an example. A piece of drying equipment failed to function when a plant was started. The chemists felt that the equipment had not been designed properly; the engineers thought that the properties of the product made on full-plant scale had been changed from those originally described by the chemists. Review showed that the real failure was lack of good coordination and assignment of responsibility. If these had been in effect, the equipment requirements would have been fully understood and checked by intermediate-scale tests.

The design of an effective pilot plant must always envision each operation as part of a full-scale procedure. Pilot-plant investigations should make only limited use of process and equipment expedients that do not lend themselves to scale-up. These expedients may be installed to get the process going quickly or to save money. The need for the use of such resorts, frequently grasped because of equipment and material shortages, is fortunately now passing from the scene. The use of the right equipment in the first scale-up will have a favorable influence on the final process.

The question should be asked occasionally during scale-up, if real creative imagination has been brought to bear in connection with the details of the process. Has sufficient time been taken to consider more radical methods of attack? Fresh viewpoints are helpful and should be sought.

In some cases the difference between economic and uneconomic manufacture of a competitive product may depend on one process detail. After the major difficulties have been solved in complicated processes, some small matter may interfere with smooth operation. This may not be recognized and promptly dealt with or else it may be handled ineptly.

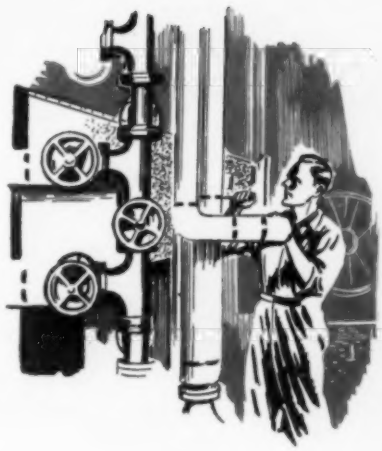
Skill and Experience

As the new process advances from the laboratory-glassware stage, all possible help from skilled chemical, engineering and process people should be sought. This will involve getting the advice and help of specialists on certain points; there are many phases of scale-up work that can be done best by those specially trained.

Examples persist where people try to cope with problems with which they are not competent to deal. The years spent in research may not measure the ability to do specialized process experimentation. This shows up clearly when an able man is assigned to a development problem that appears to be bogged down and soon presents ideas that prove to be the ones needed to achieve the desired results.

It is advisable to provide plenty of flexibility in pilot-plant equipment so that different process phases can be tested readily. The best time, from the standpoints of both convenience and expense, to do this is when the equipment is first installed. As pilot-plant operation proceeds, changes in process will be developed that will improve the product quality and the yield. If the equipment can be easily adapted to employ these changes, the resulting benefits will more than pay for the increased installation cost.

When difficulty is encountered in locating a desired piece of equipment, it is sometimes a temptation to at-



tempt to change the proposed process so that this equipment will not be necessary. This refers to cases where simple changes and adaptations to known equipment do not give the desired result or to where it is desired to avoid the time and expense involved in designing and developing something new.

Giving up the idea of such equipment should not be done without a careful review of possibilities that go beyond things near at hand. Perhaps a new point of view will suggest a way for designing the equipment in a quite different manner so that it will be easy to proceed.

Novel Equipment Ideas

On one occasion, a process needed an unusual piece of machinery that could not be located in the usual places. It was decided to visit other industries and look at their machines. A field trip turned up a type of equipment which could be altered by the manufacturer so that it would perform the desired step. In this example, it was necessary to see the original machine operating in order to visualize how it could be changed to fill the need.

In drawing up a new process cost estimate for use in determining plant construction, a factor of considerable risk is introduced by assuming proposed process changes not now in effect. This is particularly true of process phases used in the present pilot plant that result in added operating expense. These may be used currently because they provide an easier way to operate. Possibly the output of material for field evaluation is expedited by this procedure. It is highly desirable to operate the pilot plant according to the same procedure used as the basis of the cost analysis. This will

avoid embarrassment in the event that assumptions made are not borne out by subsequent data. It will, of course, be desirable to estimate process alternatives. Such estimates have the purpose of indicating possible lines of experimental work and should not be taken as a basis for scaling-up.

A useful precautionary measure is to ask a group of people not familiar with the development, but who are experienced in process technology, to study the pilot-plant operation. They may possibly operate the pilot plant themselves in order to see what they find; their suggestions should be helpful. The fact that they bring a fresh point of view is very constructive.

This group may find things that have been overlooked, and the varied experience of the different members should contribute to productive findings.

The importance of adequate detailed records should be emphasized. Extra care and time here will pay dividends. If necessary, one person should be assigned to the job of keeping master sheets of the tests made and full records of the progress achieved. These will be used finally to provide the operating instructions for start-up.

5. Avoid Past Mistakes

Some possible mistakes are described below. This list should be augmented by drawing on the experience of others.

Giving Up Too Easily

In some cases, a solution to a problem developed during scale-up may appear to provide a satisfactory answer, but it is soon found that this will introduce trouble X. For this reason, that particular line of attack may be discontinued. Very serious study should be given, in this event, to the possibilities for circumventing the trouble before dropping this attack. It may be less difficult to find a solution than appears at first glance. Consider the example in which a big improvement in yield is obtained by means of a process alteration, but at the sacrifice of some desired product characteristic. Before immediately turning the investigation toward finding alternative process steps, effort should be given to determining what can be done to improve the product property by changes in operating conditions or other refinements.

When unfavorable results occur in pilot-plant operation, the need for investigation to find the cause and cure is assumed to be evident. It sometimes happens that a ready explanation which may appear sound and logical is given to account for such difficulties. However, it is unwise to proceed with scale-up phases based on such ideas. This is particularly true where product quality is not quite as good as desired, and it is assumed that it can be made satisfactory later. The thought "We will work that one out on the big scale" should receive careful scrutiny before acceptance.

Last Minute Changes

It sometimes appears desirable to change the specifications for the proposed product to be made in the final plant from the figures used as a basis for semiworks operation. This change may be planned in the hope of obtaining improved product quality in view of recently developed data or in the belief that the yield will be improved. However, if difficulties are encountered during the start-up, this alteration will present an unknown variable. It is, therefore, better to start production with the same characteristics made in the pilot plant, and change later, or to demonstrate first that the proposed alteration is satisfactory from a process standpoint in the pilot plant.

Procedures that are changed in scaling-up can easily result in undetermined operating variables and troubles. In the event that a large amount of construction money can be saved by making a last minute alteration, the matter should receive careful study. If there is a background of similar experience to fall back on, the making of the change can be considered, otherwise it should be proved out first. Such changes come back to haunt those who made them in the event of start-up difficulties.

Time and money will be saved in the end if full operation is not started before the equipment has been proved out. The mechanical functioning of component units should perform as intended by the designers. A recent article describes a procedure followed to insure a satisfactory plant start-up by means of equipment tests.[25] Pressure to start operation before everything in the line of equipment, men and materials is ready should be resisted as it results in unnecessary headaches. If defects in equipment or process are discovered at an early stage, it is more profitable to correct them than to try to push through anyway.

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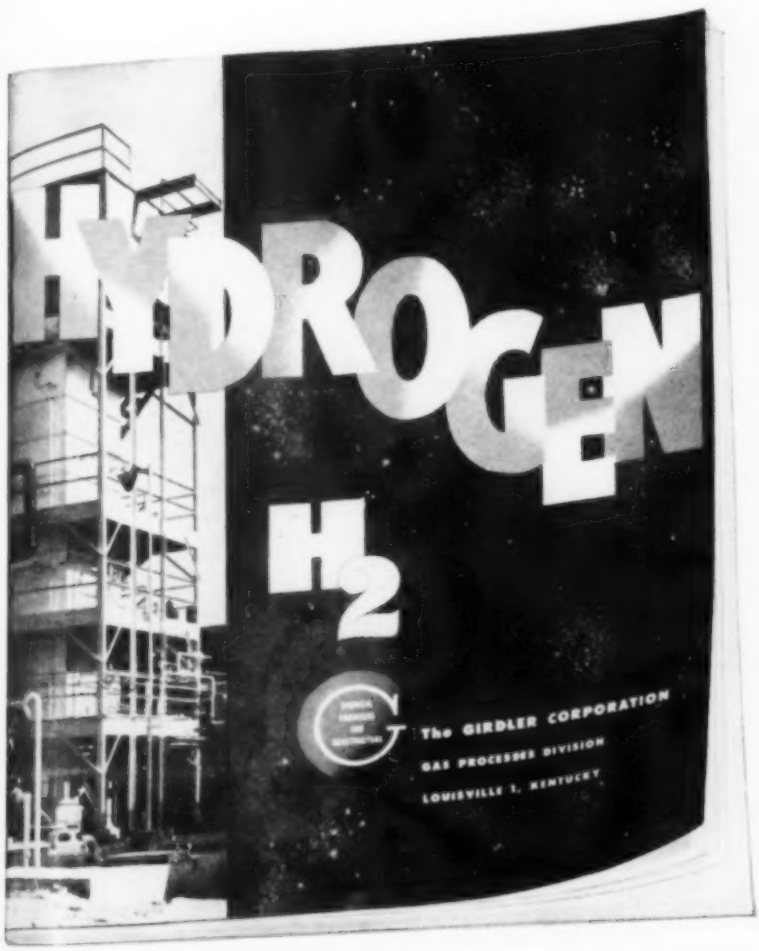

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Continuous sodium peroxide bleaching of groundwood-sulphite pulp is carried on at this Bucksport, Me., mill of the Maine Seaboard Division of St. Regis Paper Co.

CONTINUOUS PULP BLEACHING

FIRST continuous sodium peroxide bleaching of a groundwood-sulphite pulp mixture is in operation at the Bucksport, Me., mill of the Maine Seaboard Division of St. Regis Paper Co. The process consists of preparing bleaching solution, proportioning groundwood and sulphite, diluting mixed stock with white water, thickening the stock, mixing bleaching solution with shredded stock, holding peroxide-treated pulp long enough to complete bleaching, and reducing and neutralizing bleached pulp to pH needed for paper making.

Bleaching solution, prepared in an agitated dissolving tank, is a water solution of epsom salts, sodium silicate, sodium peroxide and sulphuric acid. Metered and proportioned by Trimbey meter, groundwood and sulphite pulps are mixed and diluted with white water before being pumped to Impco vacuum thickeners. Coming off the thickeners at 12 percent consistency, mixed stock is carried by repulper conveyor to the heater conveyor where steam raises its temperature to 91-95 deg. F. Dropped next into the mixer, the heated stock is shredded and mixed with bleaching solution which comes in at the mixer. Bleaching starts on contact. From the mixer the treated stock drops into the bleaching tower through which it descends as a plug in a 2¼-3½ hr. period, the bleaching continuing and the temperature falling to 86-90 deg. F. Screw conveyors at the tower bottom carry bleached stock to the chest. White water dilutes the stock to 3½-4 percent consistency. A Trimbey consistency regulator makes final adjustment to 2½ percent. Liquid sulphur dioxide lowers pH to 5-6. Bleached stock goes directly to paper machine room. For details see pp. 92-96.

CHEMICAL ENGINEERING

October, 1947

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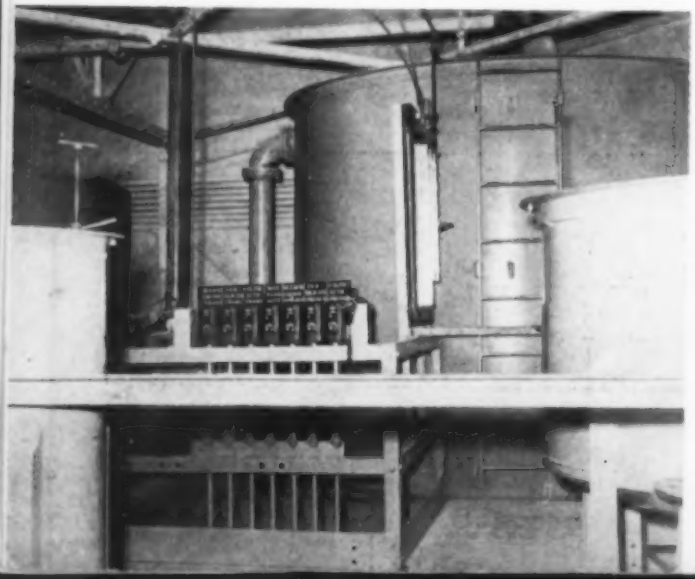
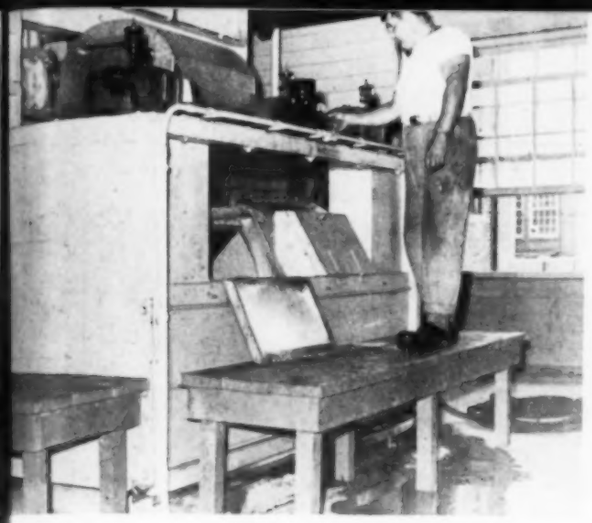
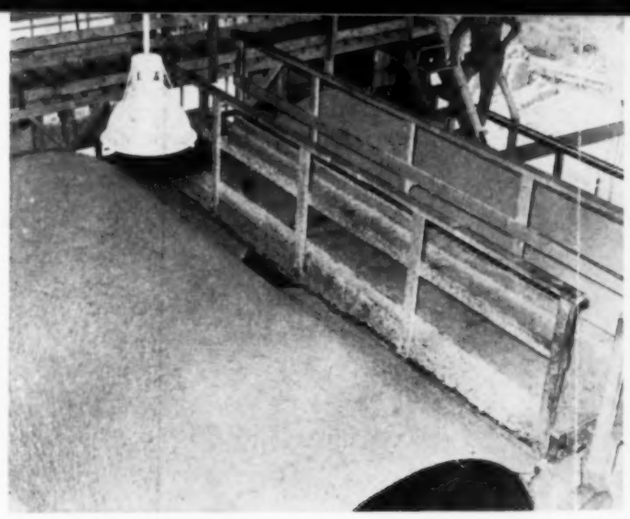
1 Through the measuring tanks sodium silicate and sulphuric acid are run into the dissolving tank



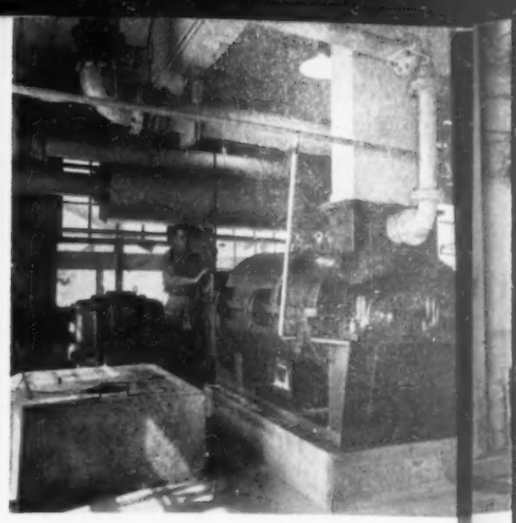
2 Operator makes ready to feed sodium peroxide into the dissolving tank wherein bleaching solution is prepared



3 Groundwood and sulphite pulps are brought together to form mixed stock. Trimbey meter controls flow and does proportioning



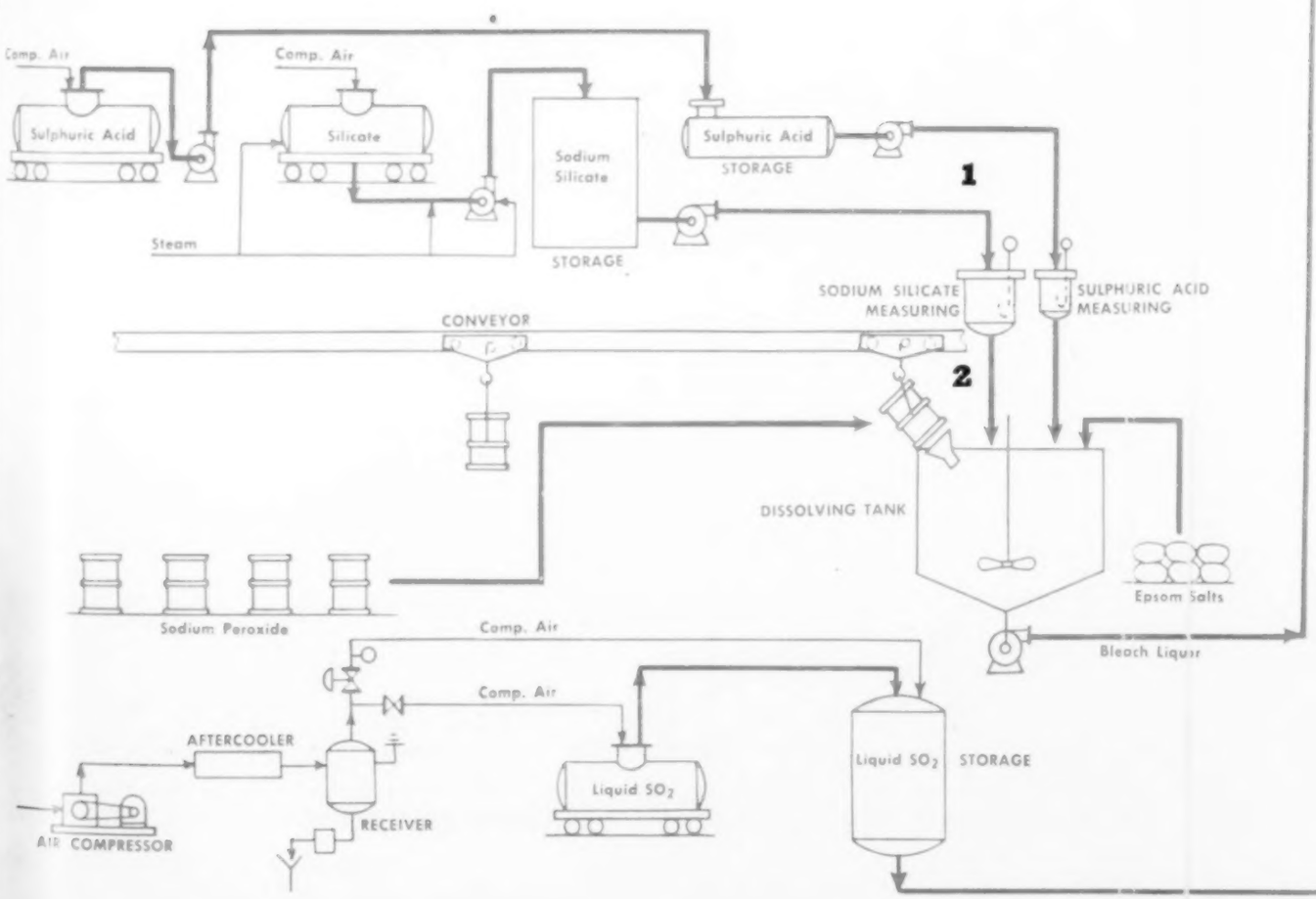
4 The mixed stock next has its consistency raised to 12 percent by removal of white water on these Impco vacuum thickeners



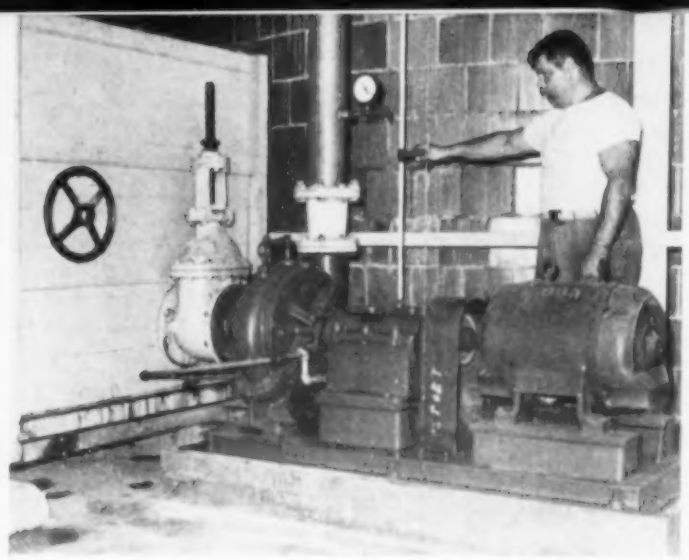
5 To the thickened stock the bleaching solution i[s] mixer. Parallel, revolving, spiked shafts in mi[x]

Chem & Met

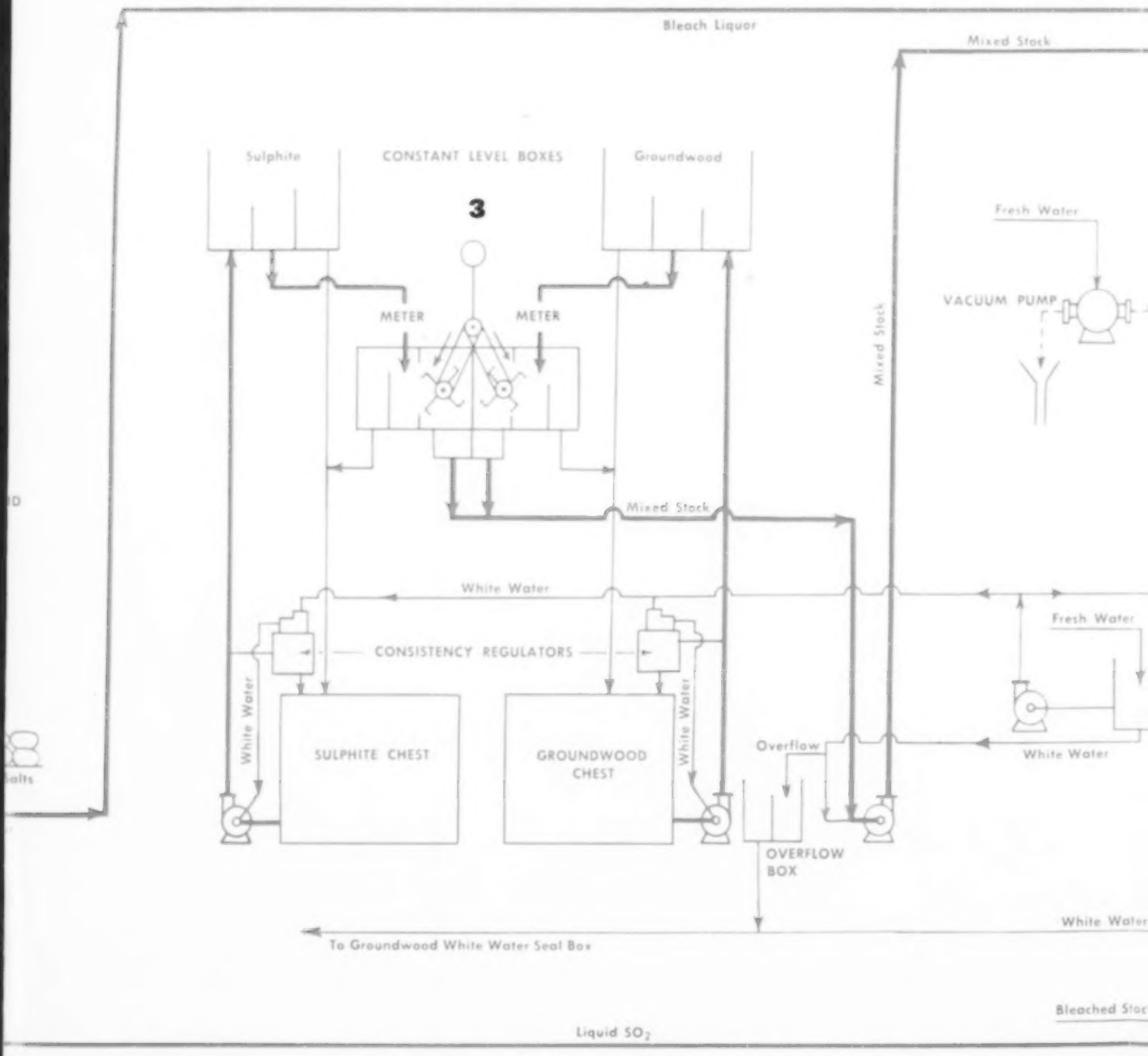
PICTURED FLOWSHEET



5 To the thickened stock the bleaching solution is added in this mixer. Parallel, revolving, spiked shafts in mixer shred stock



6 Stock and bleach remain in the glazed tile bleaching tower in the background for 2½-3½ hr. Pump distributes white water



tower in
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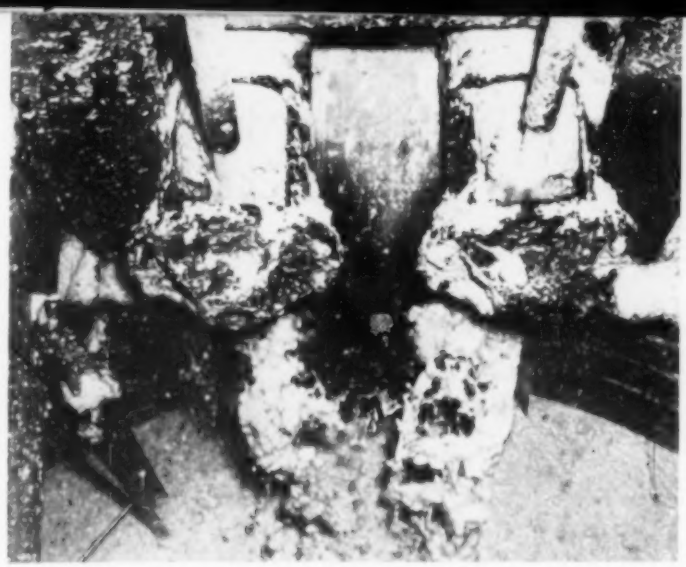
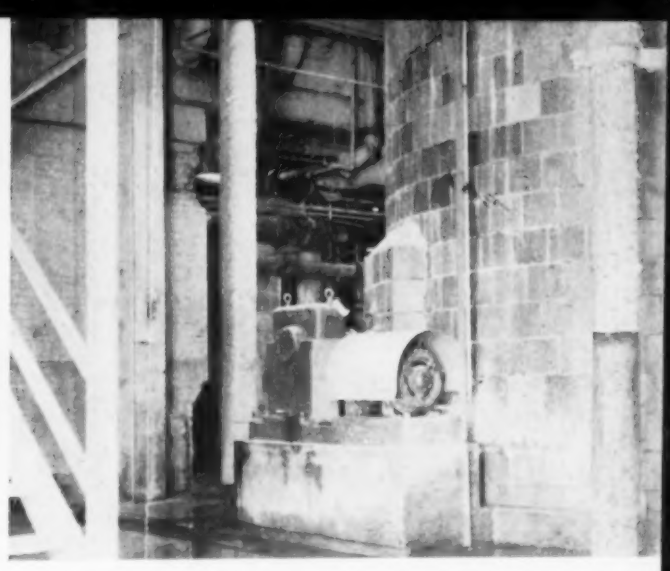
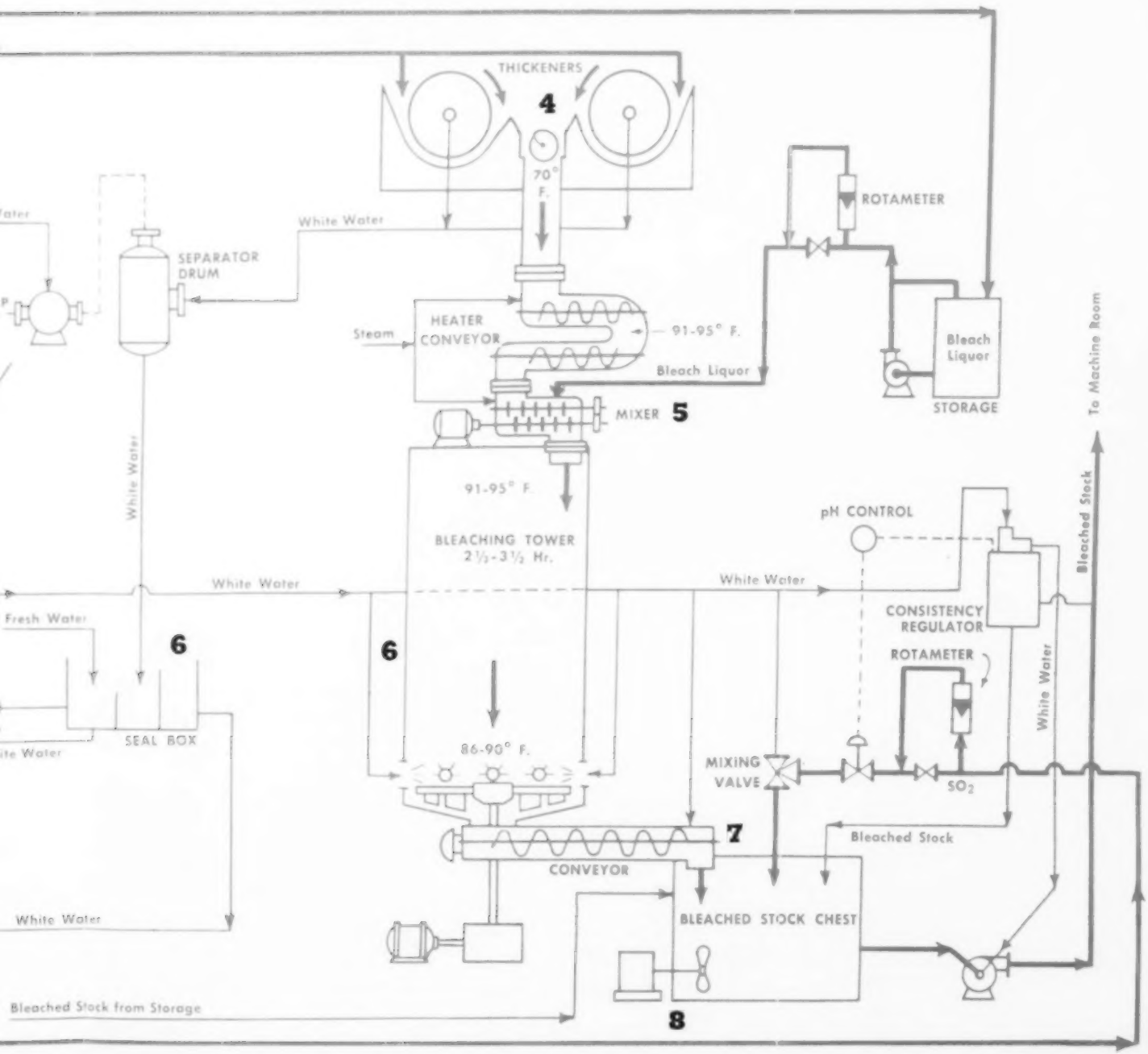


7 Bleached stock from tower is diluted and loosened by white water at exit ends of screw conveyors. Stock drops into chest



8 Finished bleached stock is pumped directly from this glazed tile chest to paper making machines



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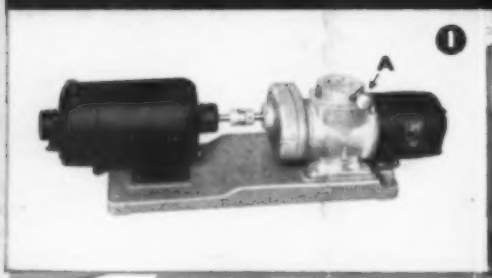

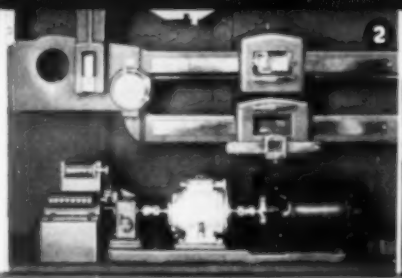

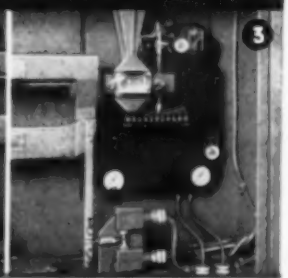

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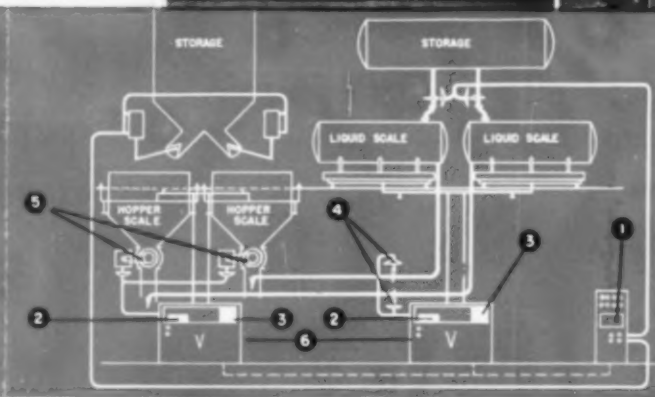
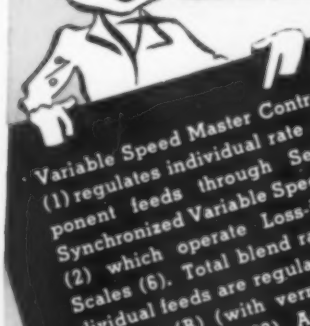


Schematic flow diagram for blending dry and liquid ingredients.



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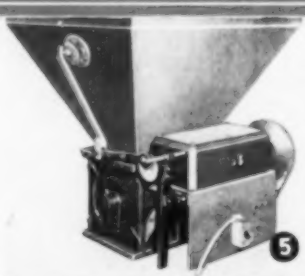

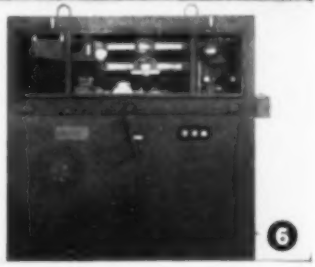

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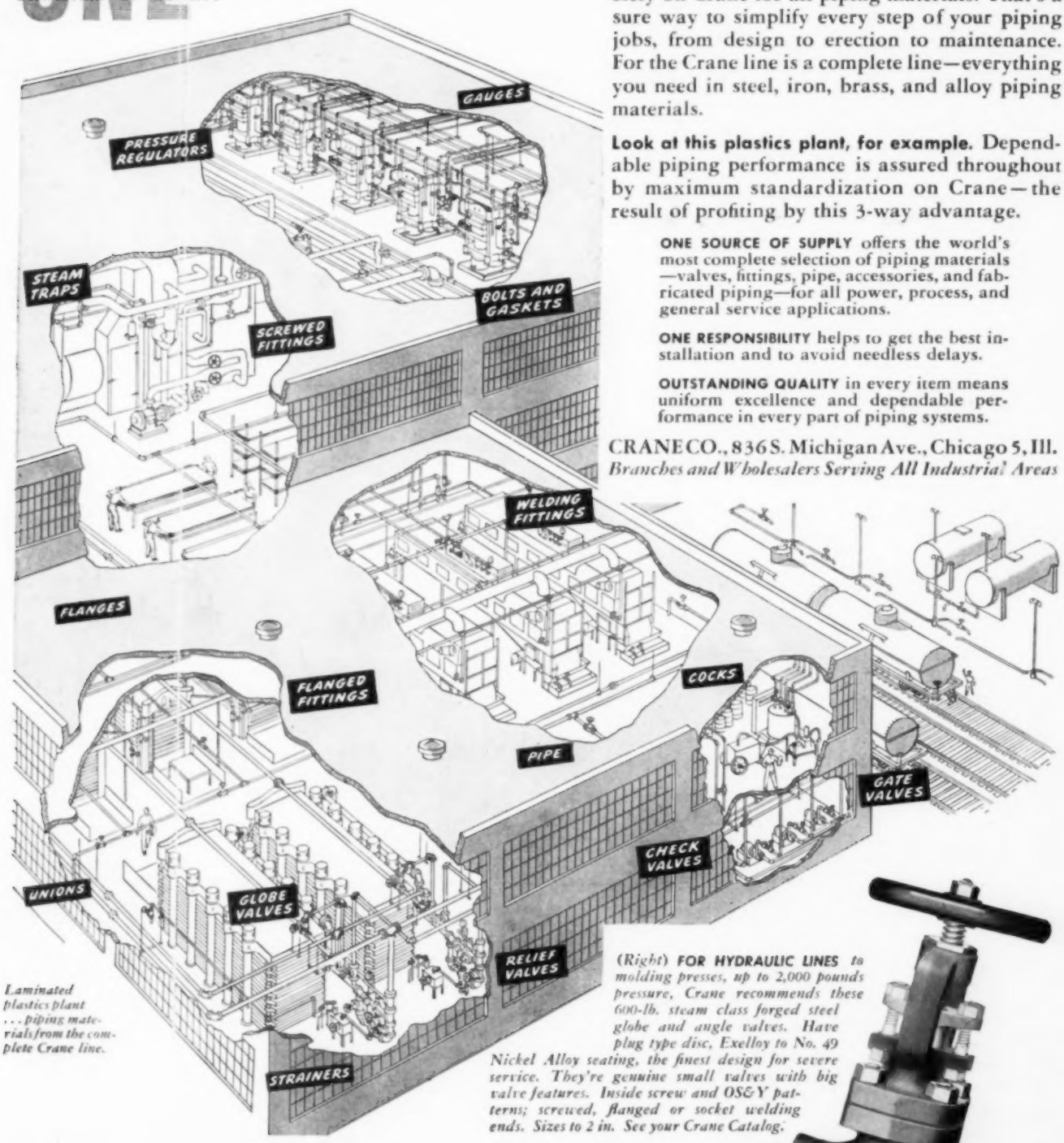

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Theodore R. Olive, ASSOCIATE EDITOR

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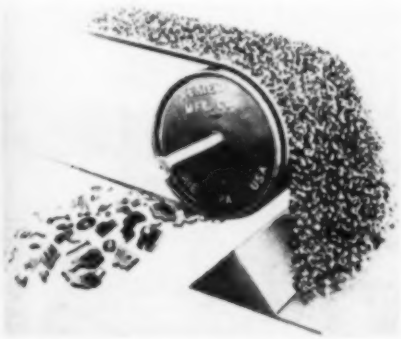
1. Magnetic Pulley



Non-electric magnetic separating pulley

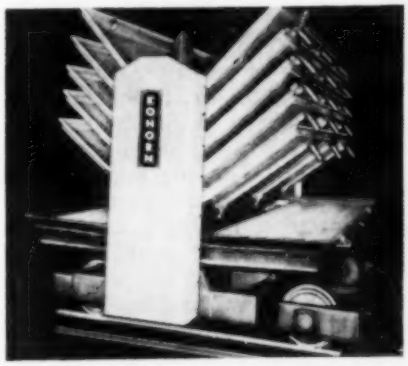
HIGH STRENGTH permanent magnets, requiring no electric current to generate a magnetic field, are now being used in the production of a magnetic pulley for belt conveyors by the Eriez Mfg. Co., Erie, Pa. According to the company, these pulleys are now used successfully on receiving belts for the removal of tramp iron from bulk chemicals and coal. They are suggested for installation ahead of crushing and grinding equipment to eliminate machinery damage and explosions caused by tramp iron, and for the removal of fine ferrous particles from resins, carbon black, abrasives, clays, etc. These units are said to work effectively through any kind of belt of non-magnetic construction. They are said to be suitable for hazardous locations where possible sparking has previously precluded the use of electrically powered magnetic pulleys.

2. Leakless Heat Exchanger

TO RELIEVE the operators of heat exchangers and condensers of leaks at the point where tubes are rolled into tube sheets, Condenser Service & Engineering Co., Hoboken, N. J., has developed a double-tube-sheet exchanger of novel design. Instead of the conventional solid tube sheet, the new type incorporates a pressure chamber between two tube sheets. The chamber is filled at all times with the desired heat exchange medium at a pressure greater than that of the circulation pump or on the shell side. When and if a leak develops between the tube sheet and any tube, the medium in the pressure chamber flows into either the end housing or the shell side, depending on which side of the double tube sheet the leak occurs. The medium selected for the pressure chamber is determined by the value of the product on either side of the tube sheet, that is, it is selected to avoid contaminating the more costly medium. The pressure medium is ordinarily supplied from a head tank, usually giving 5 ft. greater head than the circulating pump pressure. This tank is equipped with a float-actuated alarm to indicate leaks when they occur and thus warn the operator.

FOR MORE INFORMATION
See Reader Service
Coupon on pages 163-164

3. Rayon Cake Treater



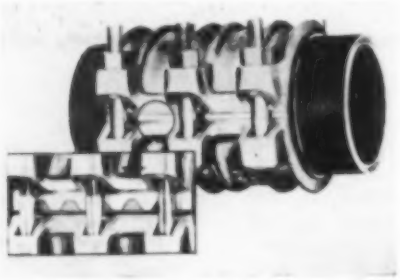
Rayon after-treater for 360 cakes

A NEW MACHINE for the after-treatment of freshly spun rayon cakes has been announced by Oscar Kohorn & Co., 501 Fifth Ave., New York 17, N. Y. The single unit shown in the accompanying illustration illustrates the principle whereby the rayon cakes are supported in vertical columns in such a way that the hollow inside of each column of cakes acts as the closed-end terminus of the wash liquor pumping system. The several trays are spring supported to remain out of the way while each layer is being loaded. Each unit has a capacity of 360 cakes, while six, eight or twelve units are used simultaneously to form the complete aftertreating system. The units are mounted on rails, and between the rails the wash liquor piping system terminates in piping which automatically engages the inlet of the manifold in the base of each machine, bringing the liquors under even pressure to the interior of every rayon cake.

As each unit is started on the rails, a fully treated unit of 360 cakes rolls off the other end of the line, advanced by a hydraulic pusher, so that the inlets always line up with the feed pipes. The new system is said to save on treatment liquors and to insure a high percentage of recirculation with consequent saving of chemicals and

heat. This equipment is now being installed in rayon plants being built abroad by this concern and is available also to existing rayon manufacturers.

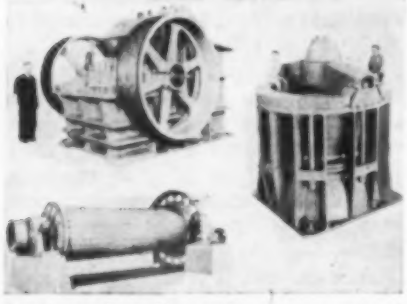
4. Pipe Repair Clamp



Full-circle pipe coupling

BOTH SIMPLICITY of installation and permanency of repair are claimed for the new cast-bronze, full-circle clamp coupling offered by Smith-Blair Co., 535 Railroad Ave., South San Francisco, Calif. This coupling, designed for broken cast-iron pipe or cement-asbestos pipe, is simply installed by bolting together the two halves of the coupling over the broken or split pipe. It is made in two widths, 7½ and 15 in. wide, for pipes with nominal diameters of 4 to 12 in. In the 4-in. size, the coupling is said to hold 1,000 lb. hydrostatic pressure. The special molded rubber gasket used with the clamp coupling is bonded to the casting and has a special copper armor which is a part of the gasket along each edge of the coupling, enabling a special finger arrangement to slide over it and mesh, so as to give complete encirclement of the pipe surface. It is claimed that one man can install the coupling in six minutes, and that the design allows for expansion and contraction of the pipe.

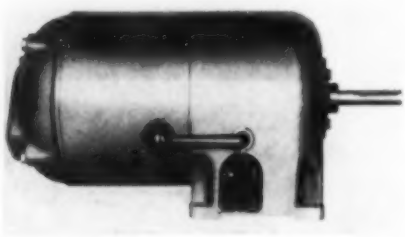
5. Grinding Machinery



Crushing and grinding equipment now produced by Nordberg

PREVIOUSLY known for its manufacture of the Symons cone crusher, the Process Machinery Division of Nordberg Mfg. Co., Milwaukee 7, Wis., has now introduced a broad line of heavy primary crushing and grinding machinery for the reduction of rock products, ores and non-metallic minerals. The primary jaw crushers include larger sizes from 30 x 42 in., up to 72 x 96 in.; the primary gyratory crushers, sizes from 30 up to 72 in.; and the grinding mills, sizes from 6 ft. to 10 ft. 8 in. in diameter, and up to 50 ft. in length. This division is also prepared now to supply rotary dryers, calciners, kilns and coolers.

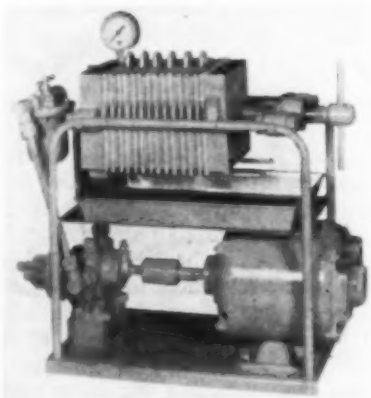
6. Gearshift Motor



Four-speed gearshift motor

FOUR GEAR ratios ranging from 1 to 1 to 4 to 1 are available in the new Type R gearshift drive with integrally mounted single-phase motor that has been announced by the Lima Electric Motor Co., 7094 Findlay Road, Lima, Ohio. The new unit is produced in sizes of ¼ hp. at 1200 r.p.m., and ⅓ hp. at 1800 r.p.m. Motors operate on 115 and 230 volts a.c., 50 and 60 cycle. Polyphase units which are mechanically identical are also available.

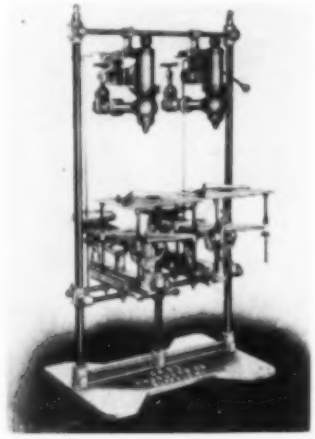
7. Portable Filter Press



60 g.p.h. portable filter press

FOR USERS of small filtration systems, including both laboratory and small production applications, the Buckeye Laboratories Corp., 6700 Morgan Ave., Cleveland 4, Ohio, has introduced a small portable filter press weighing only 70 lb. but capable of filtration at rates up to 60 g.p.h. The dimensions of the unit are 18 in. high, 14 in. long and 8½ in. wide. Incoming fluid is first passed through a Cuno filter for the removal of all colloidal particles of 0.0035 in. or larger. This serves the twofold purpose of protecting the gear pump and increasing the efficiency of the filter press itself. A built-in relief valve maintains fluid pressure below 60 psi. without interrupting the filtration process. The ⅓-hp. motor operates from a standard lighting circuit.

8. Liquid Filler-Weigher



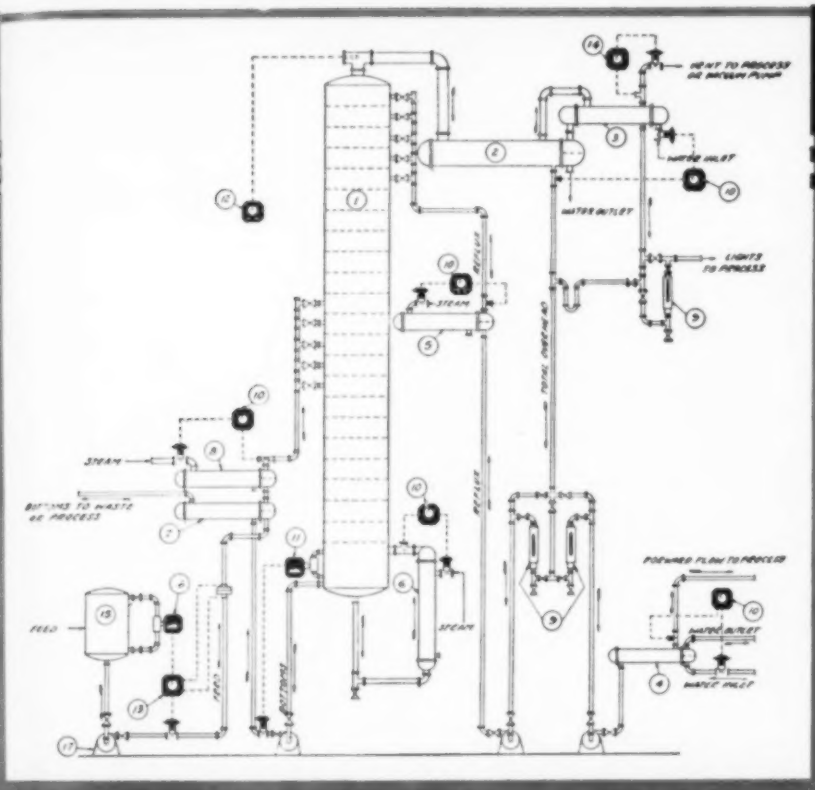
Double type liquid weigher and filler

BOTH MECHANICALLY operated and electrically operated liquid filling and weighing equipment in a variety of single- and multiple-unit types has been introduced by Cass Products Co., 27 Mechanic St., Buffalo 2, N.Y. This equipment, suitable for the packaging of a variety of free-flowing liquids, is produced for handling the filling of containers ranging from 2 oz. to 5 gal. volume capacity. The mechanical type employs a specially constructed even-balance scale combined with a quick-acting mechanical trip. The electrical machine is similar, except that the mechanical tripping mechanism is replaced with an electrically operated trip. The latter is claimed to give faster action and finer weight adjustment. All types are said to be readily cleaned and quickly adjusted to various delivery capacities.

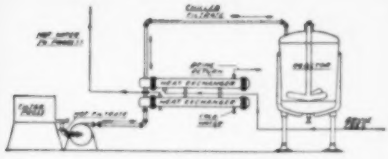
9. Mixed Flow Pumps

FOR THE HANDLING of extremely large volumes of water, in capacities up to 220,000 g.p.m., the Peerless Pump Division of Food Machinery Corp., 301 West Ave. 26, Los Angeles 31, Calif., has introduced a line of mixed flow pumps which embody characteristics of both centrifugal and axial flow pumps. Features of the pump include its ability to move liquids against maximum heads with minimum submergence, adaptation to shallower sumps, utilization of higher speed motors against medium heads,

Complete Engineering Service FOR PROCESS OPERATIONS

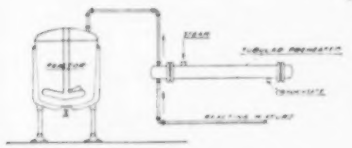


KEY: 1. Fractionating Column 2. Primary Condenser 3. Secondary or Vent Condenser 4. Condensate Cooler 5. Reflux Preheater 6. Reboiler (Vertical Thermosyphon) 7. Bottoms-Feed Heat Exchanger 8. Feed Preheater 9. Rotameters 10. Temperature Controllers 11. Liquid Level Controllers 12. Recording Thermometer 13. Flow Controller (Pneumatic Set) 14. Pressure or Vacuum Controller 15. Feed Accumulator 16. Level Buoy Controller 17. Centrifugal Pump



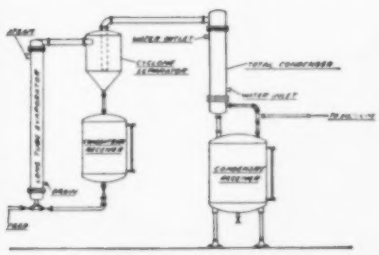
HEAT EXCHANGER

Fig. 1. Suggested arrangement using two heat exchangers for cooling in a process step. Refrigeration tonnage kept to a minimum with dual units. Heat recovery also an advantage.



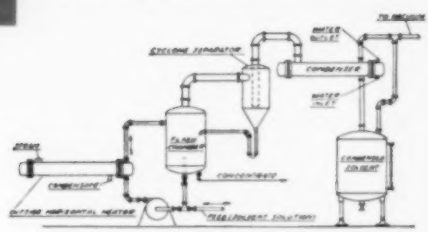
HEATER

Fig. 2. A common use of tubular units for preheating reaction ingredients in order to speed up a batch cycle. Same system used where reactor has an overflow for continuous operation.



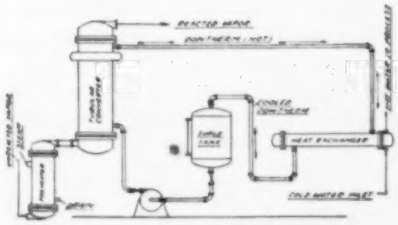
EVAPORATOR (Natural Convection)

Fig. 3. Suggested arrangement for continuous evaporation. This type of assembly often employed for heat sensitive mixture—minimum contact time with heating surface. Temperature control essential.



EVAPORATOR (Forced Convection)

Fig. 4. Continuous forced feed single effect evaporation assembly with or without vacuum. Temperature and liquid level controllers essential for proper operation.



TUBULAR CATALYTIC REACTOR AND HEAT EXCHANGER

Fig. 5. Standard design tubular equipment employed for vapor phase catalysis in an exothermic reaction.

IN serving the Chemical and Food Processing Industries for more than 25 years, Pfaudler is being called upon more and more to furnish equipment for the complete process, including the engineering of the installation.

In meeting this demand, Pfaudler utilizes any material of equipment construction that best meets requirements . . . glass-lined steel, stainless steels (and other alloys), mild steel, etc. In fact, Pfaudler is the only manufacturer experienced in the production or fabrication of all such materials.

Typical equipment supplied, and coordinated with other types, includes reactors, heat exchangers, stills, mixers, storage tanks, pipe, fittings, valves, etc. Wherever possible, *standard* Pfaudler designs are used. Thus, you obtain established performance at the lowest cost. Take advantage of this experience on *your* next problem. Literature describing the equipment illustrated on request.

Pfaudler

Branch Offices: 330 West 42nd St., New York 18, N.Y.; 111 W. Washington Ave., Chicago 2, Ill.; 1325 Howard St., San Francisco 3, Calif.; 818 Olive St., St. Louis 1, Mo.; 63 West Milwaukee Ave., Detroit 2, Mich.; 1318-1st Nat'l Bank Bldg., Cincinnati 2, O.; 1041 Commercial Trs. Bldg., Philadelphia 2, Pa.; 751 Little Bldg., Boston 16, Mass.; The Chattanooga Bank Bldg., Room 334, Chattanooga, Tenn.; Enamelled Metal Products Corp., Ltd., Artillery House, Artillery Row, London, S. W. 1, England.

THE PFAUDLER CO., ROCHESTER 4, NEW YORK

ENGINEERS AND FABRICATORS OF CORROSION RESISTANT PROCESS EQUIPMENT

Glass-Lined Steel . . . Stainless Steels . . . Nickel . . . Inconel . . . Monel Metal

and its installation in minimum space.

These pumps are included in the company's Hydro-Foil line which also encompasses pumps of the propeller type. The name comes from the claim that new principles of aero- and hydrodynamics are employed in the design to minimize water turbulence and power loss. Both single- and multi-stage units are available. The design employs a pump bowl which functions as a diffuser. Impellers are in effect modified propellers. Drives, available in sizes from 1 to 1,000 hp., include belted, direct motor-operated and turbine-driven.

10. Multi-Louver Dryer

Multi-Louver dryer for granular materials

UNDER the name of Multi-Louver, the Link-Belt Co., Dryer Division, 300 West Pershing Road, Chicago, Ill., has introduced a new design of dryer (or cooler) intended especially for materials requiring short treatment time and/or multiple drying temperatures. It is possible to dry, cool and process materials in the same unit. The moving element in the dryer consists of two strands of roller chain with specially designed flights, suspended in such a way as to provide means for keeping the material in a constantly flowing mass. The material flows in a shallow bed over the ascending flights, and at the same time is gradually moved across the dryer from the feed point to the discharge point. No cascading or dropping of the material takes place, but only a gentle flowing action which is said to result in practically no degradation within the dryer. Special applications can be made where it is desirable to treat the product with different temperatures in different zones, or a cooling section can be provided on the discharge side.

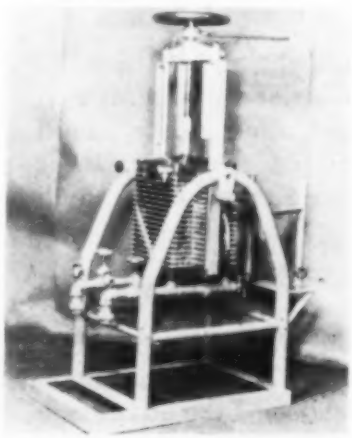
Hot gases from the furnace are introduced in such a way as to permeate the moving bed of material. The exhaust gas housing is so designed that the gas velocity decreases immediately after heat transfer takes place, so that it is claimed that only the smallest size dust particles escape from the drying chamber. The drying air can be heated by steam coils or any fuel.

11. Duplex Strainer

Duplex continuous flow strainer

TO PERMIT continuous flow in pipe lines, the J. A. Zurn Mfg. Co., Erie, Pa., has introduced a new duplex sediment strainer in which flow can be diverted from one basket to the other without interrupting passage through the strainer. The unit operates by means of a single plug type valve whose openings direct flow from the inlet to either basket, or to both simultaneously. A relieving yoke is provided to seat the plug tightly for sealing, or to loosen it for turning. Sizes of 1 to 6 in. or larger are available in steel and a variety of alloys.

12. Filter Sheet Tightener



Filter with new tightening device

INTENDED for use by pharmaceutical manufacturers, particularly in the batch filtration of penicillin and similar products, and for use in the manufacture of whiskeys and other beverages, is the model V-16 sheet filter announced by Hercules Filter Corp., Paterson, N. J. The filter incorporates a new tightening device which is said to eliminate loss through production of an optimum drip-proof seal. The single-spindle tightening device includes a long ratchet lever which may be seen extending to the right beneath the handwheel in the accompanying illustration. The filter employs this company's pivoting feature whereby the unit operates in the vertical position as shown, but can be tipped to horizontal for cleaning and applying new filter medium. Owing to this feature, users of paper with diatomaceous earth can stop and start without disturbing the filter layers and it is not necessary to maintain pressure on the filter to keep the precoat from dropping off.

13. Compact Mixer

Small production muller mixer

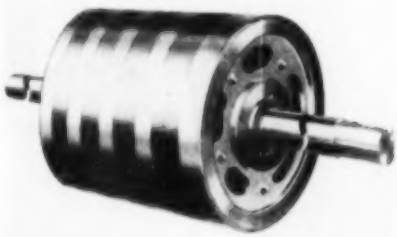
DESIGNED for small production, pilot plant and laboratory work, a new muller-type mixer designated as Model 00 is being offered by National Engineering Co., 604 Machinery Hall Building, Chicago 6, Ill. This new member of the line of Simpson Intensive Mixers is said to be suitable for blending practically all types of dry, semi-dry, and plastic materials. The unit is entirely self-contained, has a capacity of ¼ to ½ cu. ft. per batch, and is provided with a V-belt variable-speed drive requiring only 1½ hp.

14. Disk Agitator

A NEW TYPE of impeller for agitators, which operates at full motor speed and thus requires no gearing, has been introduced under the name of Velofin by Davidson & Serner, 342 Madison Ave., New York 17, N. Y., and Commercial Trust Building, Philadelphia 2, Pa. This impeller, which is adaptable both to stationary and to portable agitators, consists of a number of parallel disks, closely spaced. During rotation these disks impart a rapid helical motion to the liquid, solely by means of surface friction, with the

liquid discharged tangentially and at high velocity over the entire disk periphery. As liquid passes through the agitator it separates into a number of thin layers to which the differential motion is imparted, thus, it is claimed, resulting in instant mixing. Varying the number of disks and their size and spacing is said to permit an infinite variety of operating conditions to be met to suit any viscosity or density, as well as any motor power or motor speed. Furthermore, any given impeller can quickly be adjusted to meet varying operating conditions.

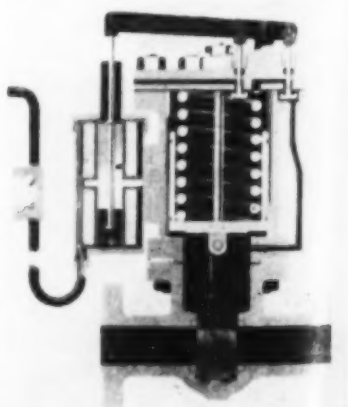
15. Separating Pulley



Permanent magnetic pulley for conveyors

As an addition to its line of permanent-magnet tramp-iron separators, the Homer Mfg. Co., Lima, Ohio, has announced a permanent magnetic pulley designed for use as a head pulley in belt conveyor systems, to remove ferrous metal particles and pieces from materials being conveyed. These pulleys are built of cast aluminum and steel and are available in all standard diameters above 10 in. and in widths which are multiples of 6 in. It is claimed that extremely powerful magnets are employed and that the pulleys are amply ventilated to dissipate any heat created by belt slippage or friction.

16. Valve Controller



Cross-section of electric valve control

REMOTE electric control, coupled with a servo mechanism to provide the operating energy, is employed in a new

for Every User of Worm Gears

This new 48-page, data-filled catalog gives all the information necessary for the selection of correct worm and gear sets for any given requirement. It includes information concerning selection practice, worm gear rating tables, instructions for computing bearing loads, standard worm and gear dimensions and other information necessary to those requiring high grade worm gear sets for use in their own equipment. A copy of this important catalog will be mailed to you on request.

WORM GEAR DIVISION

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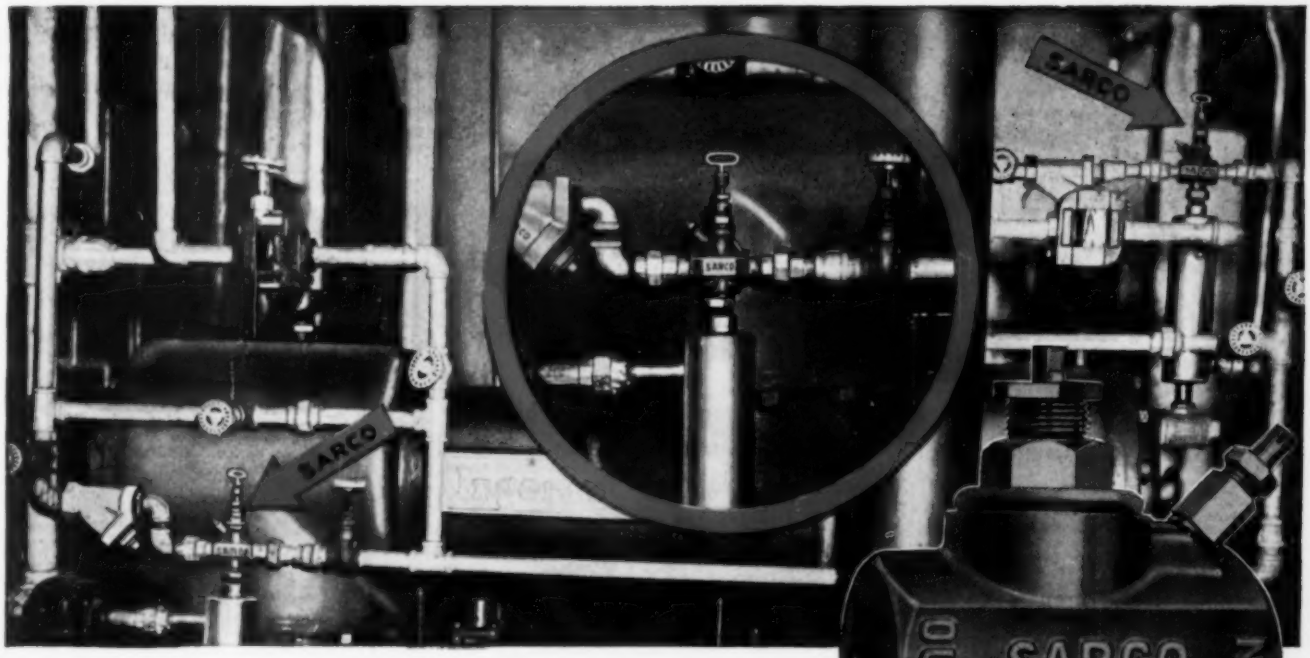
FOR MORE INFORMATION
See Reader Service Coupon on pages 163-164

electric valve control offered by Shafer Valve Co., Mansfield, Ohio. This control, which gives either the fully opened or fully closed position, can be adjusted for speed of valve operation and requires the energizing of the operating solenoid only while the valve is being opened or closed. The electric control requires only three wires and two control switches at the operating center. The valve servo gives a small amount of exhaust while opening or closing, but vents no exhaust in either open or closed position. This controller can also be provided for manual operation. It can be controlled by fluid pressure from a controller, or from a manual four-way valve at the control center.

17. Continuous Weigher

Diaphragm-supported belt weigher

KNOWN as the Conveyoflow Meter, a new continuous weighing machine for dry materials carried on conveyor belts has been announced by Builders Providence, Inc., Providence, R. I. A novel feature is found in the method of supporting the weighing section. The idlers carrying the weighing section of the belt are supported at one end by self-aligning ball bearings, and at the other end by a diaphragm which transmits load changes hydraulically to the weighing mechanism. A cyclometer type totalizer reads directly in any units desired, employing the well-known disk-and-wheel integrating principle, which is automatically corrected for any belt speed variation. A system of return belt weighing is used for automatic compensation of the recorded weight for variations in belt weight and for adherence of material to the belt. The new weighing principle results in the elimination of many parts ordinarily required, giving



LESS WATER-LESS OIL-CLEAN AIR

and Greater Compressor Efficiency

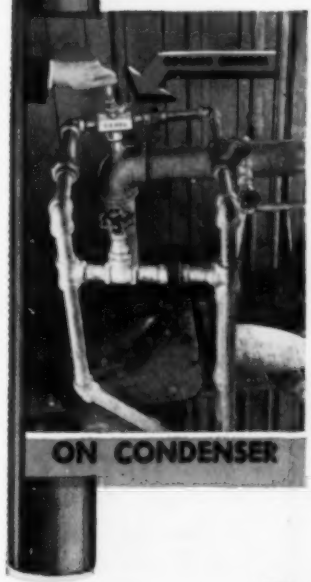
TR 40 COOLING CONTROL

Sarco TR-40 Cooling Controls, applied to your air compressor, will save four ways, and it's a question which of these will prove most valuable to you.

Water consumption will be cut 25 to 50%. By preventing under-cooling, lubricating oil will be saved.

No burned oil can get into your air lines because overheating is definitely prevented. Correct jacket water temperature, automatically maintained, will increase compressor efficiency.

The TR-40 Cooling Control installed on the 3-story-high condenser shown at the right saved three-fourths of the water, increased the output and insured uniformity. It is used extensively on degreasers and food equipment and is frequently found as part of the original equipment. The cost is small—quickly recovered. Ask for Catalog No. 700.



ON CONDENSER

139

SARCO SAVES STEAM

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Represented in Principal Cities

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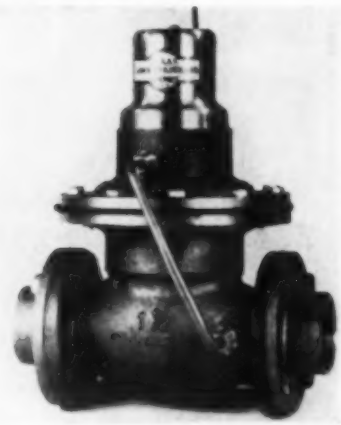
a simpler unit requiring less floor space. This weigher may be used for proportioning and control, as well as simple weighing.

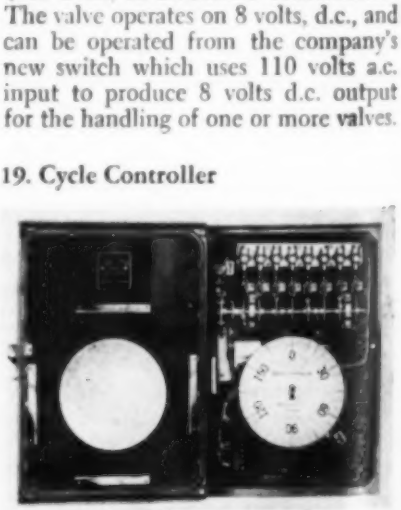
18. Electric Valve



Remote operated electric valve

FOR USE on water, gas, oil and other fluids under normal temperatures, Texas Lawn Sprinkler Co., 2613 Elm St., Dallas 1, Texas, has introduced a new line of Electro-Matic valves and switches, permitting remote control of fluids by electrical means. The valve can be used in conjunction with thermostats, time clocks, float switches, pressure switches and other electrical devices. An actuating coil is provided to cause the valve to open or close instantly. Diaphragm construction is said to assure positive operation, while moisture-proofing permits installation underground or in wet places. These valves are available in five sizes from ¾ to 2 in., in all-bronze construction. The valve operates on 8 volts, d.c., and can be operated from the company's new switch which uses 110 volts a.c. input to produce 8 volts d.c. output for the handling of one or more valves.

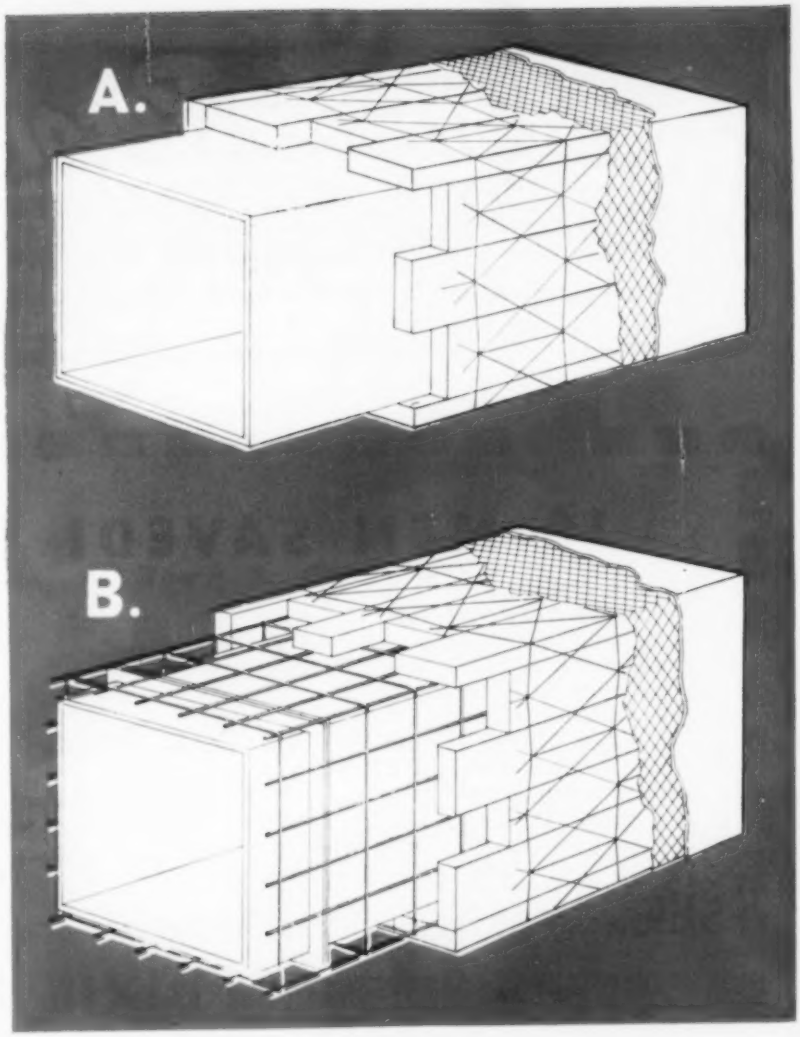
19. Cycle Controller



Model C 500 impulse-sequence cycle controller

FOR OPERATIONS requiring the time cycle control of a number of factors, such as the opening and closing of valves, switches, dampers, retorts and presses, and the starting, stopping or reversing of pumps or blowers, the

How would YOU insulate this breeching?



Here's the problem:

A metal breeching carries gases of combustion at temperatures from 500° to 575° F. from boiler to economizer. Which method of insulating the breeching will be most satisfactory?

A. 3" 85% Magnesia block applied directly to duct?

B. 3" 85% Magnesia block applied over air space?

Here's what the Armstrong engineer recommended

The first method costs less than the second—but it isn't best for this particular job.

Direct application of insulation is entirely satisfactory on hot air ducts and other applications where more moderate temperatures are involved. But in the case of this breeching, temperatures as high as 575° F. often occurred. With insulations applied direct, deterioration of the metal as well as the Magnesia might result.

The breeching can be protected by an air space between the metal and the insulation. Although the original job will cost slightly more, it will be less expensive than early replacement.

The air space can be provided either by welding pencil rods to the stiffener flanges (as shown here) or by applying V-ribbed metal lath, with 1" ribs on 18" centers which keep it away from the duct. After the magnesia is applied, it is wired in place, covered with hexagonal mesh wire and two coats of asbestos cement.

Safety factors like this cost money, but they offer economy in the long run, and good engineers are careful to include them in all their calculations. In this case, the low-cost job might last. But the chance that rises in temperature would cause it to go bad is too great to take. The Armstrong engineer is trained to size up all possibilities and recommend methods which cut risks to the minimum.

When you work with Armstrong's Contract Service, the insulation specification is written for your special requirements—it's filled with exactly the materials your job calls for—and it's installed by skilled craftsmen. The entire Armstrong organization takes responsibility.

FREE INSULATION CHART

This chart lists types and thicknesses of insulation for temperatures from 300° below zero to 2800° F. Write today to Armstrong Cork Co., Industrial Insulation Department, 3310 Maple Ave., Lancaster, Pennsylvania.

ARMSTRONG'S INDUSTRIAL INSULATION

Complete Contract Service For All Temperatures

From 300° Below Zero

To 2800° Fahrenheit

FOR MORE INFORMATION
See Reader Service Coupon on pages 163-164

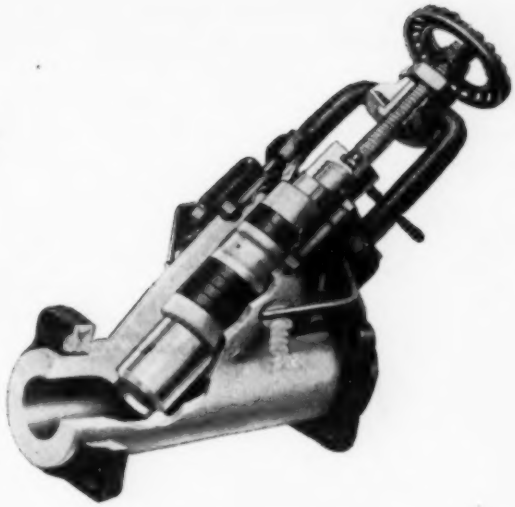
Bristol Co., Waterbury, Conn., is now offering a new cycle controller known as Model C 500. A feature is that the time measurement and pilot valve operation are handled by separate mechanisms. Timing is accomplished by a Telechron-driven aluminum disk on which a time scale is printed. The desired schedule of operations is incorporated into the controller by cutting notches with a notching punch on the time scale. Disks for new cycles or operation schedules can easily be made. The cams which operate the pilot valves are individually adjustable and do not require fine adjustment to secure accurate results. Controllers are drilled for eight cams and pilot valves, and in those initially supplied with a smaller number, the number can be increased to eight at any time by the user.

20. All-Aluminum Drum

30-gal. aluminum chemical drum

DESIGNED specifically for shipping hydrogen peroxide, but suitable also for a wide variety of other chemicals, a new 30-gal. all-aluminum chemical drum was recently announced by Reynolds Metals Co., 2000 South Ninth St., Louisville 1, Ky. The new drum meets I.C.C. Specification 42-D. Some of the other materials for which it is suited include pharmaceuticals, glacial acetic acid, nitric acid of 80 percent or higher strength, benzine, ether, vegetable, mineral and animal oils. The drum, which is 30½ in. high by 18 in. outside diameter, not including the reinforcing rings, weighs 34 lb., compared with 65 to 70 lb. for a steel drum of comparable strength. The manufacturer points out that the reduction in weight as compared with a steel drum would result in a saving in freight cost of almost $90 per car on

Why Non-Porous



Chemical Porcelain for Corrosive Liquids?

THE ability of Lapp Chemical Porcelain to resist corrosion is due in large measure to the non-porous nature of this ceramic material. Not only is this material inert to most corrosive acids, but its non-porous characteristic means that there is no absorption, no capillary forces from absorbed liquids, no exposure of the material other than the surface to corrosion. At Lapp "vitrified" and "non-porous" are not loose or relative terms. They refer to a Lapp ceramic material which can withstand the routine dye-immersion test: exposure of a test sample to a penetrating dye under pressure of 100,000 lbs./in.^{2} for a 24-hour period without trace of penetration.

Valves and other processing equipment of solid Lapp Porcelain have brought dependable operation and laboratory purity to hundreds of chemical processing systems. Write for literature. Lapp Insulator Co., Inc., Process Equipment Division, Le Roy, N. Y.

Lapp

PROCESS EQUIPMENT

CHEMICAL PORCELAIN VALVES • PIPE • RASCHIG RINGS

PULSAFEEDER CHEMICAL PROPORTIONING PUMPS

a typical shipment of chemicals from Buffalo to Louisville. The return shipment of empty drums would save almost $40 per car.

21. Resistance Meter

Beckman UltrOHMeter for resistance

KNOWN AS the UltrOHMeter, a new instrument for making unusually sensitive current and resistance measurements has been introduced by the National Technical Laboratories, 820 Mission St., South Pasadena, Calif. Current sensitivity to as low as 2×10^{-13} amp. at full scale permits resistances as high as 1×10^{16} ohms to be measured directly. The instrument is battery-operated, containing a built-in standard voltage source providing convenient steps from 0.5 to 20 volts for resistance measurements. Other important features include: Internal resistor calibration means, generous range overlap (23 ranges), minimum current sensitivity of 5 micro-amp., and minimum resistance of 100,000 ohms. Both positive and negative signals can be measured.

Equipment Briefs

22. FASTER and more flexible action is claimed for a new pneumatic controller, for chemical plants and refineries that has been announced by Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. The new controller can be supplied for temperature using thermocouples, radiation type detectors, or resistance thermometers; pH; gas analysis; and electrolytic conductivity. The control can also be adapted to various types of instruments, including both the Micromax and the Speedomax. Various modes of control, including simple proportioning, reset and derivative types, can be secured.

23. FOUR FILAMENTS, assembled in appropriate chambers and wired in a balanced bridge arrangement, are employed in the new thermal conductivity analyzer for gases, offered by

VESSEL DIVISION

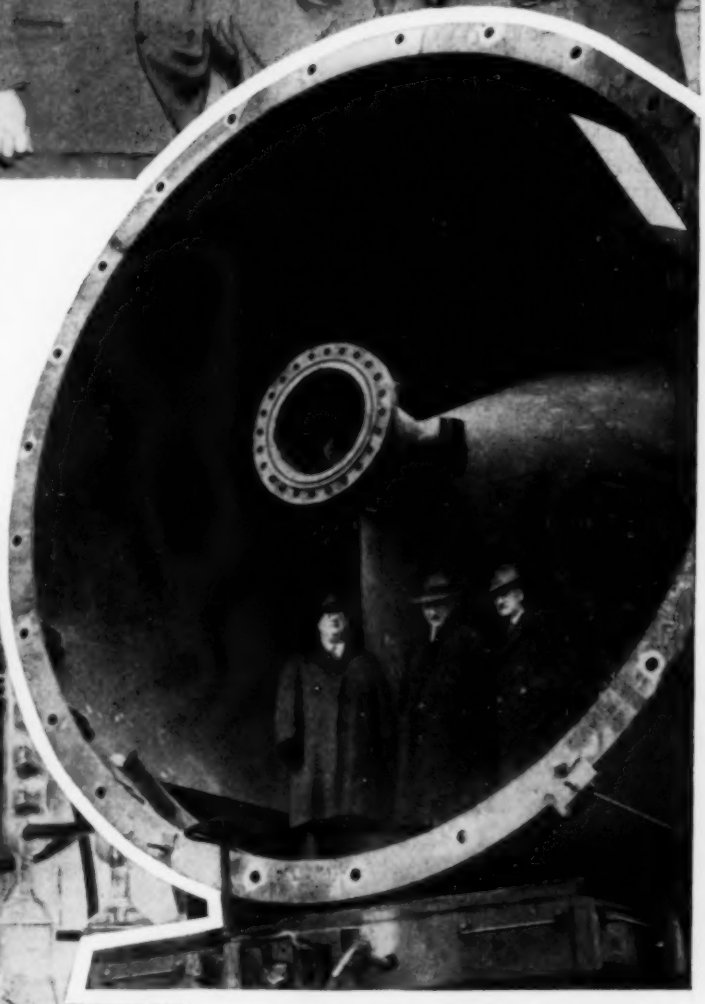
NEWS

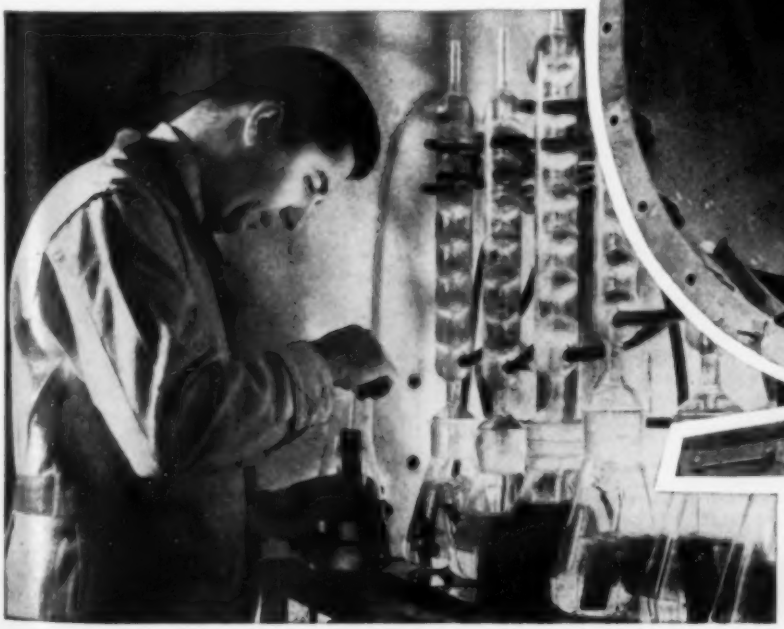
A. O. SMITH Corporation

New York 17 • Philadelphia 5 • Pittsburgh 19 • Atlanta 3 • Chicago 4
Tulsa 3 • Houston 2 • Seattle 1 • Los Angeles 14
International Division: Milwaukee 1

FIELD SALES MANAGERS VISIT NEW VESSEL HEADQUARTERS. Warren Hendrickson, New York; Bill Jackel, Chicago; Georges Pateneaux, International; and Tabe Mahler, Los Angeles, get a personal tour of the newest building on the A. O. Smith property in Milwaukee, guided by Henry Needham, Vessel Division Manager.

TWINS THAT AREN'T TWINS! A. O. Smith metallurgical engineers discovered that successive heats of the same alloy react differently in service to corrosion. Then they figured out how to determine before fabrication that a particular heat would resist corrosion satisfactorily.





REMEMBER JONAH AND THE WHALE? A. H. Zastrow (left), traffic manager for A. O. Smith, starts on a complex trip by rail and water with one of the largest shop-fabricated vessels ever built. 16 feet diameter and 106 feet long, this oil-refining vessel weighs over 320,000 lbs.

FOR MORE INFORMATION
See Reader Service Coupon on pages 163-164

Gow-Mac Instrument Co., 22 Lawrence St., Newark 5, N. J. The device is low in cost and is claimed to be extremely flexible in gas train sampling. It requires only standard instruments and accessories for use. When used with any suitable source of constant voltage, the degree of unbalance of the bridge circuit provides an accurate measure of the relative thermal conductivity of an unknown gas, or the quantitative variations in a known gas.

24. A PRESSURE gage designed especially for corrosive service has been placed on the market by the Jas. P. Marsh Corp., 2073 Southport Ave., Chicago 14, Ill. Designated as the Type 105 Mastergage, the unit is recommended for use with such materials as acetic acid (non-aerated), various alcohols, sodium acid sulphate, sodium chloride, oxalic acid (cold), sulphite solutions, various organic acids, sulphuric acid (cold), alum solutions, and others. The gage uses a lathe-turned beryllium copper bourdon tube with a special bronze-bushed movement and bronze pinion and arbor.

25. ESPECIALLY designed for handling corrosive and abrasive liquors where severe wear is encountered, a new pump produced by Allis-Chalmers Mfg. Co., Milwaukee, Wis., is now available for process industry use. Pump parts subject to severe wear are all separate pieces, easily replaced. Adjustable wearing clearance insures maintenance of capacity and efficiency without dismantling the pump. Five sizes with capacities to 1,300 g.p.m. at 275 ft. head are now being produced. A unique feature of the pump is the arrangement whereby the suction is brought in on the stuffing box side so that the sealing pressure is limited to the suction pressure. The long stuffing box provides for both water and grease seals.

26. AS AN addition to its line of heavy-duty induction motors, Electric Machinery Mfg. Co., Minneapolis 13, Minn., has introduced a two-pole, squirrel-cage type for high-speed applications such as boiler feed pumps, oil pipe line pumps, compressors and blowers. The motor is rated from 200 to 700 hp. at 3,600 r.p.m.

NEW PRODUCTS AND MATERIALS

Richard W. Porter, ASSISTANT EDITOR

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51. Water Paint Vehicle

A DISPERSION of synthetic poly-vinyl resin in water is the vehicle of the new Gelva paint developed by the Shawinigan Products Corp., 350 Fifth Ave., New York, N. Y. The pigment and poly-vinyl resin are suspended in water with the aid of one percent or so of synthetic wetting agent. Four advantages are said to result directly from the use of water to thin the emulsion vehicle instead of the volatile solvents required by paint pastes based on oils. They are: freedom from odor, reduced fire hazard, economy and freedom from toxic effects. Possible physiological reactions of persons to vapors, common with oil paints, is also eliminated. At the same time its watery vehicle is said to make Gelva paint easy to apply with brush or spray. Complete drying takes place in half an hour. Progressive oxidation of the vehicle is not required for drying this paint. Greater durability of the final film is achieved in this way affording protection to delicate tinted pigments. The range of colors and tints in which Gelva is made extends from dense black through regular colors and pastel tints to pure white. Although the new paint contains water as the thinning agent in the emulsion, the dried resin film possesses a degree of resistance to washing and scrubbing as great as that of oil paints. In the process of drying by evaporation of water from the emulsion, the minute particles of resin coalesce to form a continuous film as the final product. The small amount of synthetic surface agent employed to form and stabilize the emulsion is too tiny to affect the water resistance of this final resin film. The makers claim this gives Gelva paint films a resistance to water, weathering and scrubbing higher than that of either the usual kalsomine type finishes or the resin-oil-water emulsion paints employing casein as the emulsifying agent. Both of these leave casein in the final film in amounts sufficient to lower or destroy its resistance to washing. This synthetic vehicle derived from coal, lime and water is not irregular in quality or scarce of supply as are the natural drying oils of vegetable and marine origin. Although only interior finishes are now being made with this vehicle, production of exterior paints will probably begin soon.

52. Lubricating Compounds

A SERIES of lubricating compounds is being manufactured by Glyco Products Co., Inc., 26 Court St., Brooklyn, N. Y. The twelve lubricants range from liquids to solids and from water-soluble or water-dispersable materials to oil-soluble materials. One of the series is both water and oil dispersible. Developed for drawing, sheeting and stamping non-ferrous materials, certain members are well adapted to wet drawing, others for dry drawing. For wet drawing, a solution of 2 to 5 percent Glycolube and water usually is most satisfactory. In some processes, the stock to be drawn dry may be dipped into a solution of the lubricant before the operation, then allowed to dry and then processed. This makes possible reduction of the amount of lubrication at the die. Where a series of dies are applied in dry drawing, the use of Glycolube is said to reduce the number of lubrication boxes required. Increased operating speeds and prolonged life of the dies with which they are employed result from the use of Glycolubes, according to the manufacturer. They are said to yield a brighter product and automatically apply a film which acts as a temporary corrosion inhibitor. These lubricants do not break down during operation or produce scum. Continuous lubrication is therefore permitted since there is no necessity for continually renewing or discarding the lubricant.

53. Saran Rope

ACCORDING to a recent announcement, Plymouth Cordage Co., North Plymouth, Mass., are now manufacturing a Saran rope claimed to have good chemical resistant properties. Laboratory and service tests show that acids, alkalis (except concentrated ammonia) and most organic solvents have no damaging effect on this new Saran rope. For the manufacture of rope, Saran is extruded as continuous monofilaments, the size, shape, strength and color of which can be varied through wide ranges. Plymouth Saran rope is made with three strands, but the number and size of yarns differ from those in corresponding sizes of manila rope. The following tabulation covers a range of sizes that the manufacturer has made and tested.

Nominal Diameter, In.	Net Weight of 100 Feet, Lb.	Average Length in One Pound, Ft.	Minimum Breaking Strength, Lb.
3/16	1.47	68.0	260
¼	2.73	36.5	560
5/16	3.93	25.1	730
⅜	5.66	17.6	990
½	10.3	9.7	1,770
9/16	14.0	7.15	2,630
⅝	17.7	5.62	3,120
¾	23.2	4.3	4,020
⅞	32.0	3.12	5,700
1	42.5	2.35	8,000
1¼	67.0	1.51	12,000

When compared with manila rope,

it is noted that the weight of Saran rope in corresponding sizes is from 35 percent to 60 percent greater. The minimum breaking strength of Saran is approximately 70 percent of the strength of manila rope. Saran rope is flexible and easy to handle, but the filaments are more slippery than natural fibers. When splicing, extra tucks and seizing the strand ends to each other are recommended to prevent slipping. Resistance to abrasion is not as good as that of manila or sisal rope. It has a tendency to lose strength gradually at high temperatures but can be recommended for use in temperatures up to about 170 deg. F. It has been used satisfactorily in higher temperatures where the full strength was not required. Strength lost as a result of over-heating is not regained upon cooling. Saran rope will not support combustion. Exposure to the weather does not reduce the strength of this rope nor does alternate wetting and drying change its properties. It does not swell and stiffen when wet and soften again upon drying. Wet strength is the same as the dry strength. Its weight does not increase appreciably when wet, and there is no shrinkage when wet at normal temperatures. Saran rope will not rot and is not subject to destruction or deterioration by marine organisms. Use should be found for it in the chemical processing industries that employ acids, alkalies, or organic solvents which have a corrosive or deteriorating effect on natural fiber ropes.

54. Plasma Albumin

The fractionation of bovine blood as well as the isolation of plasma albumin in crystallized form has been accomplished by the Armour Laboratories, Chicago 9, Ill. Through their efforts during the war to develop a blood plasma substitute, they have developed the following biochemicals which are now available: bovine plasma albumin, crystallized; fraction V (bovine albumin); fraction I (bovine fibrinogen); trypsin, crystallized; chymotrypsin, crystallized; pepsin, crystallized ribonuclease, crystallized; lysozyme, crystallized; adenosine triphosphate.

55. Insecticide

Less toxic to warm-blooded animals than DDT, monoxychlor, a chemical insecticide, is now being manufactured on a small scale by E. I. duPont de Nemours and Co., Wilmington, Del. Technically called bis (methoxyphenyl) trichloroethane, it is an analog of DDT. Indications are that it will control most of the same pests on fruit crops. Although it is

not equal to DDT in combating the coddling moth, it is superior when used against flies and Mexican bean beetles. Both insecticides are said to be effective against the apple leaf hopper, apple red bug, apple maggot, rose chafer, Japanese beetle, grape leaf hopper, grape berry moth, grape bud beetle, Oriental fruit moth, pear thrip, little fire ant on citrus, tarnished plant bug on peaches and pears, and sucking bugs that cause distortions on peaches.

56. Sealing Tape

A WIDE range of industrial applications has been claimed by the Pittsburgh Plate Glass Co., 632 Duquesne Way, Pittsburgh, Pa., for Nu-Chrom-seal tape. Adhesive on both sides, it is said to be clean to handle and high in dielectric values. Baking temperatures as high as 375 deg. F. will not affect it. It resists gasoline, oil or water. Readily trimmed with the finger nail or a blunt instrument, the consistency of the tape allows easy tailoring around radical contours.

57. Bleaching Clay

OFFERED recently by Innis, Speiden & Co., 117 Liberty St., New York, N. Y., is a new bleaching clay. Known as Adsorbol, this material is an absorbent clay available in both the natural and activated state. Its chief use is in colorizing vegetable, marine, nut and sodium oils. The bleaching agent is said to be useful in the recovery of crank case oils and dry cleaning solvents.

58. Liquid-Plastic Coating

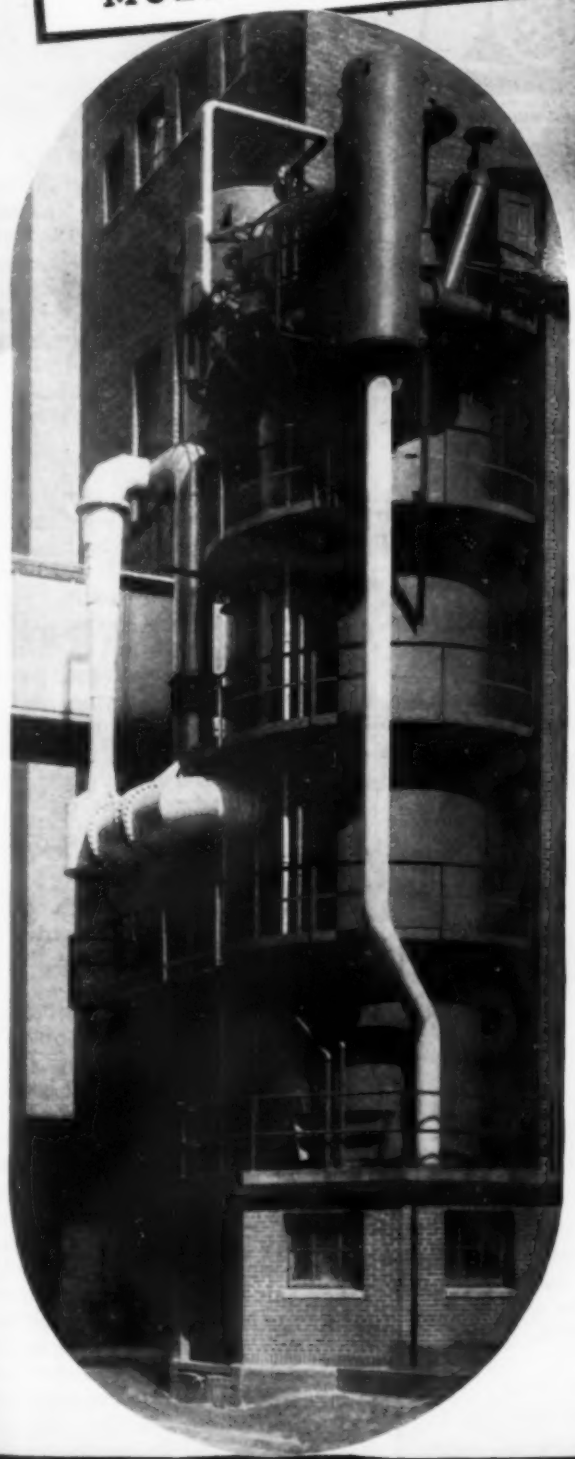
A LIQUID-PLASTIC called Redskin, manufactured by Dennis Chemical Co., 2700 Papin St., St. Louis, Mo., is being marketed as a protective coating for polished or bright metal surfaces. The elastic film that forms after the liquid is applied by brush, spray or dipping repels rust, chemical reaction and smears caused by normal handling. Neither atmospheric nor climatic changes affect the coating. Parts covered by this film may be completely fabricated before its removal by peeling.

59. Hydrocarbon Samples

FOR CALIBRATING analytical instruments and apparatus in the laboratories of the petroleum, rubber, chemical and allied industries, seven new standard hydrocarbon samples have been made available by the National Bureau of Standards, Washington, D. C., and the American Petroleum Institute. Distributed in 5 ml. samples sealed in

GUARDITE

MULTI-STAGE EVAPORATIVE COOLER



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DOUBLE PIPE COOLERS

These coolers are equipped with automatic cleaning and sterilization features set at pre-determined intervals. Cleaning or sterilization occurs while cooler is "on stream." All internal surfaces are accessible for inspection and cleaning during periodic shut-downs. Designed for either continuous or batch operation to cool from as high as 360°F. to as low as 60°F. All operations are automatically controlled to minimize operator attention.

There are no moving parts to wear. These units can be furnished in sizes to meet your requirements and fabricated of the proper materials to meet your conditions. When writing please state kind and quantity of material to be cooled and temperature range, amount and temperature of cooling water available, steam available and pressure.

We will be pleased to give complete information as to operation and costs.

The GUARDITE CORPORATION

Vacuum Process Engineers

332 S. MICHIGAN AVENUE • CHICAGO, ILLINOIS

FOR MORE INFORMATION
See Reader Service
Coupon on pages 163-164

vacuum in a Pyrex glass ampoule, the purity of each has been evaluated from measurements of freezing points. Costing $35 each, the amount of impurity in mol percent in the compounds is as follows: 2,2,4-trimethylhexane, 0.30 ± 0.20 percent; 2,3,3-trimethylhexane, 0.13 ± 0.06 percent; 2,3,5-trimethylhexane, 0.30 ± 0.20 percent (estimated by analogy with isomers subjected to similar purification), n-butylcyclopentane, 0.034 ± 0.025 percent; 1-hexene, 0.14 ± 0.08 percent; trans-2-hexene, 0.17 ± 0.11 percent; and 2-ethyl-1-butene, 0.10 ± 0.04 percent.

60. Permanent Ink

A NON-CORROSIVE, non-poisonous and non-flammable ink has been placed on the market by the Stewart Research Laboratory, P. O. Box No. 173, Benjamin Franklin Station, Washington, D. C. Having the brand name of Glink, this ink is claimed to stick to glass, marble china, porcelain or ceramics. After drying, it is not affected by any of the common laboratory solvents such as alcohol, acetone, turpentine, toluene, ethylene dichloride, carbon tetrachloride, etc.

61. Vinyl Ethers

Now in production by the Carbide and Carbon Chemicals Corp., South Charleston, W. Va., are the first three in a new series of chemicals, the vinyl ethers. Vinyl ethyl ether is being produced in commercial quantities and vinyl isopropyl ether and vinyl ethylhexyl ether in experimental quantities. Other vinyl ethers will be produced as the demand for them develops, and a series with from one to eight carbon atoms in the alkyl group is anticipated. Extremely reactive and offering possibilities both in chemical syntheses and in polymerization to adhesives and plastic compositions, they undergo most of the reactions typical of unsaturated organic compounds. Reactions unique to themselves include isomerization to saturated aldehydes, combination with alcohols to form mixed acetals, hydrolysis under acidic conditions to yield the corresponding alcohol and aldehyde and the addition of organic acids to form mixed ether-esters. The chlorination of vinyl ethyl ether is of particular interest in the synthesis of sulphathiazole, since the reaction of

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and get of Alcoa Alclad Aluminum

You can use Alcoa Aluminum Condenser Tubes safely with almost all types of aggressive cooling waters. The integral lining inside these Alclad Tubes reduces the danger of perforation. Beyond that, aluminum is highly resistant to a wide variety of chemicals and petroleum products.

Because of the high conductivity of aluminum . . . 1509 B.t.u./hour/sq. ft./inch/degree F . . . condensers and heat exchangers of Alcoa Aluminum work at high efficiency. And because these aluminum tubes are light in weight and easy to roll in, fabrication and erection costs are less.

Right at the start you'll probably find that Alcoa Alclad Aluminum Condenser Tubes cost less per foot than the tubes you are now using. We'll be glad to give you prices and design data. ALUMINUM COMPANY OF AMERICA, 2151 Gulf Building, Pittsburgh 19, Pennsylvania. Sales offices in 55 leading cities.

LOW ORIGINAL COST

HIGH RESISTANCE TO CORROSION

RAPID HEAT TRANSFER

LOW MAINTENANCE COST

LIGHT WEIGHT

MORE PEOPLE WANT MORE ALUMINUM FOR MORE USES THAN EVER

ALCOA FIRST IN ALUMINUM

IN EVERY COMMERCIAL FORM

thiourea with α,β dichlorethyl ether gives practically quantitative yields of aminothiazole. The vinyl ethers can easily be polymerized in either the liquid or vapor phase, with a variety of catalysts. The polyvinyl ethers range from liquids to rubbery solids and wax-like balsams. As adhesives, they have been used in surgical tapes and elastic bandage tapes where they have been found to be more stable to light and show better storage stability than rubber. Copolymers of the vinyl ethers have been prepared with vinyl acetate, acrylic esters, acrylonitrile and styrene. They have been used as plasticizers and tackifiers for synthetic rubbers and nitrocellulose and as modifiers for alkyd and polystyrene resins.

62. Protective Cream

A CELLOPHANE-LIKE film to guard the hands against non-aqueous caustics, irritants and grime has been made available to consumers by Cadet Laboratories, Inc., Worcester 5, Mass. Hand-Saver, a cream, is rubbed into clean, dry hands and a protective casing is formed which may be removed by water. Made of emulsified fats and oils, it is harmless to the skin.

63. Alkyd Resin

HIGH alkali resistance, color retention and compatability with urea or melamine formaldehyde resins and nitrocelluloses are the qualities of a new non-oxidizing phthalic alkyd resin according to its manufacturers, the Resinous Products & Chemical Co., Philadelphia, Pa. Known as Duraplex ND-78, it will combine with urea formaldehyde resins to form vehicles particularly suited for white baking enamels for washing machines, hospital equipment, stoves and kitchen cabinets. With nitrocellulose it produces high quality laquers for furniture, automobiles, and metals requiring general purpose pigments.

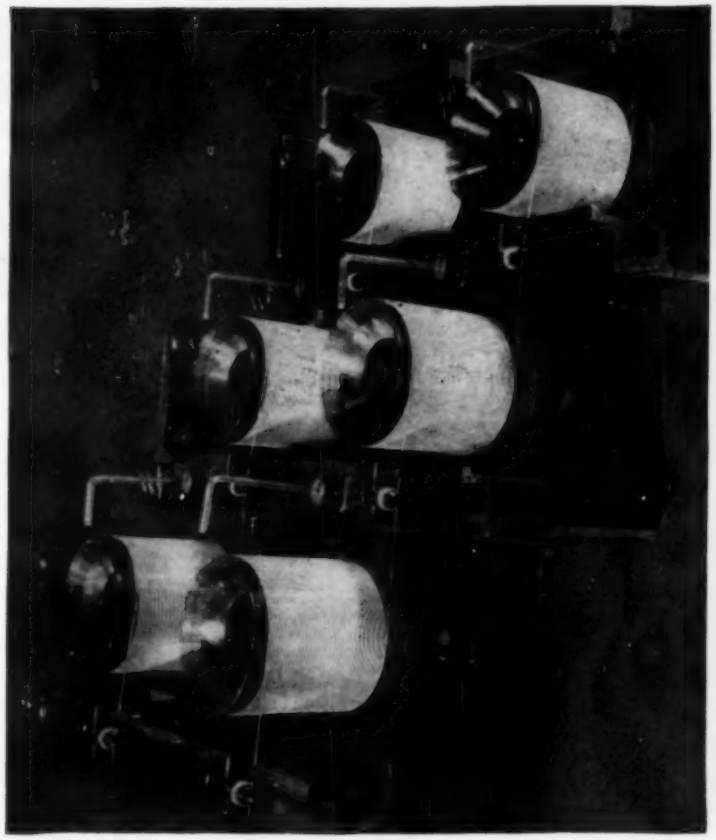
64. Fatty Acid Esters

QUANTITY production of AHCO fatty acid esters has been announced by Arnold, Hoffman & Co. Inc., Providence, R. I. Low volatility, low acidity, improved heat stability and mild odor are said to characterize these esters. They are suggested for use in the manufacture of cosmetics, plastics, coatings, leather, lubricants and allied products.

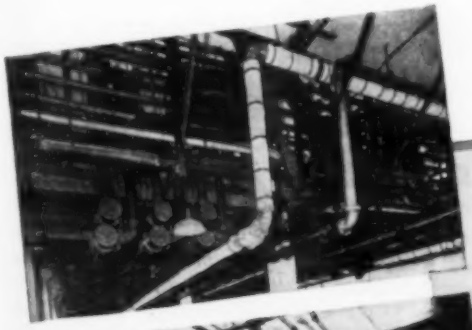
65. Polyethylene Glycol Esters

Now being produced by the Quaker Chemical Products Corp., Conshohocken, Pa., are surface active agents of non-ionic type. Known as Quak-

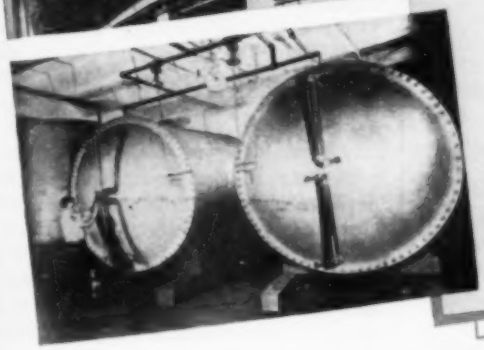
ACE
HARD RUBBER PROTECTION
for Rayon Equipment



Cross section view of ACE Hard Rubber reel trays–Typical of Industrial Rayon's continuous spinning operations.



12 miles of ACE pipe, sizes 1½" to 8", have given excellent service for years in this rayon plant



Two horizontal tanks with full ACE hard rubber protection are shown here

Corrosion break-downs are just too costly to risk, and ACE hard rubber gives the surest, most economical protection for rayon equipment. That's why in modern plants you see so many ACE rubber-lined tanks for storage and processing—ACE rubber-protected pipes, fittings, valves and pumps for handling acids, bleaches, and dyes—and a host of special ACE hard rubber or Saran machine parts.

Our engineers will be glad to show you where ACE can save for you.

Write for Catalog No. 300-6

esters, these polyethylene glycol esters cover a wide range of chemical and physical properties depending on the molecular structure. Some are high in emulsifying power, others are good detergents, plasticizers and dispersing agents. They are suggested for use in the manufacture of cosmetics, pharmaceuticals, paper, paints, plastics and adhesives.

66. Mercapto-Thiazine

DEVELOPED by the B. F. Goodrich Chemical Co., Cleveland 15, Ohio, is 2-mercapto-4,6,6-trimethyl thiazine. A yellow, crystalline material, insoluble in water but soluble in ketones and esters, it readily produces derivatives such as esters and metal salts in good yields. Heterocyclic in nature, it reacts as a tautomeric compound with the active hydrogen atom shifting from sulphur to nitrogen as the reaction conditions are changed. It is easily dimerized and the dimer produced is reactive. As an intermediate 2-mercapto-4,6,6-trimethyl thiazine may find application in the manufacture of wetting agents, pharmaceuticals and other specialty chemicals.

67. Painting Aids

THREE new Time Saver products have been put on the market by the Celco Corp., 110 East 42nd St., New York 17, N. Y. Time Saver Paint Remover, a liquid or semi-paste, removes paint and other types of finishes without harming metals or darkening or raising the grain of wood, veneer or composition board. Paint Thinner, "Best Grade," dilutes or reduces oil paint, enamels, varnishes, oil stain and fillers. It is claimed that the Thinner removes wax from linoleum or wood. With Celco 109 added, Time Saver Rust Solvent-Penetrating Oil retards rust in fittings of every kind.

68. Dihydric Alcohol

NEWLY offered to industry in experimental quantities by the Celanese Corp. of America, 180 Madison Ave., New York, N. Y. is 2-methyl-1,3, pentanediol. Containing one primary and one secondary hydroxy group, it has solubility in a wide variety of resins and is miscible with most common organic solvents. This new glycol is particularly characterized by its high boiling point (215 deg. C.), and limited solubility in water (10 parts glycol in 100 parts water). The manufacturer suggests its use in soaps, detergents, softeners, and penetrants, in oils, hydraulic fluids, greases and lubricating oils, and as a plasticizer and coupling agent for resin solutions and printing inks.

CHEMICAL ENGINEERING NEWS

Richard F. Warren, ASSISTANT EDITOR

EIGHTH CHEMICAL ENGINEERING AWARD GOES TO MERCK FOR WORK ON STREPTOMYCIN

CHAIRMAN Alfred H. White, on behalf of a committee of more than fifty leading educators in the field of chemical engineering, has announced that Merck & Co., Inc., is to receive the eighth biennial Award for Chemical Engineering Achievement. This is the chemical engineering profession's outstanding recognition for group effort in pioneering the large-scale production of the new "wonder drug," streptomycin, and other vital medicinals. It also recognizes personnel policies and practices that have encouraged Merck's chemical engineers to participate in all phases of the company's rapidly growing business and industry.

"Merck's development of streptomycin," reported S. D. Kirkpatrick, secretary of the Committee of Award and editor of *Chemical Engineering*, which has sponsored this award since 1933, "is an outstanding example of the pioneering use of chemical engineering in the large-scale production of biochemical products. Discovered as recently as 1944 by the Russian-born biologist, Dr. Selman A. Waksman of Rutgers University, streptomycin was first developed by Merck's research laboratories as a complementary antibiotic to penicillin and by clinical studies was proved effective for urinary tract infections, for certain types of tuberculosis and against Gram-negative bacteria where penicillin would not serve. After pilot-plant experiments had developed a practical production process, the WPB in August 1945 authorized large-scale plant construction. Within nine months after this work was started, plants at Elkton, Va. and Rahway, N. J., costing $3,500,000 were in successful operation. By early 1947 production capacity had been increased to over 500,000 grams per month. This is sixteen times the total production of the entire industry before Merck's plants started operation."

George W. Merck, president, will receive the Award on behalf of his associates at a dinner of the chemical engineering profession in the Waldorf-Astoria Hotel in New York on December 3—a feature event in the week of the national Exposition of Chemical Industries. Dr. Vannevar Bush, wartime director of the OSRD and the new chairman of the Research and Development Board will discuss important relations of biology and engineering and resulting advances of science and industry. Dr. H. Corwin Hinshaw, of the Mayo Clinic, Rochester, Minn., leading research authority on chemico-therapy and the investigation of experimental tuberculosis, will speak on the medical significance of streptomycin and related pharmaceuticals that have resulted from biological research. Reservations for the dinner can be secured through the editorial department of *Chemical Engineering*.

ACS Holds Its National Meeting In New York

ELEVEN THOUSAND chemical engineers and chemists gathered together in New York last month to attend the 112th National Meeting of the American Chemical Society. They heard more than 800 papers on recent technical developments in atomic energy, plastics, rubber, fuel technology and almost every other field of scientific activity.

Seven outstanding scientists were honored at a general assembly of the society at Manhattan Center on September 15. Among those receiving awards were Prof. Warren K. Lewis of M. I. T. who received the Priestley Medal for distinguished services to chemistry, and Prof. Glenn T. Seaborg of the University of California, co-discoverer of plutonium, who was awarded Alpha Chi Sigma's $1,000 American Chemical Society Award.

Tank Barges To Deliver Liquid Chlorine

AFTER a trial period of about three years in transporting liquid chlorine in a tank barge, a new fleet of tank barges will be put into operation by Columbia Chemical Division of Pittsburgh Plate Glass Co. and its affiliate, Southern Alkali Corp. Dravo Corp., Pittsburgh, in collaboration with engineers of the chemical companies, de-

Press Association, Inc.

Prof. Warren K. Lewis, Massachusetts Institute of Technology, receives the Priestley Medal for distinguished services to chemistry, from Prof. W. Albert Noyes, Jr., University of Rochester, and president of the American Chemical Society

signed the eight new all-steel tank barges that will make up the chlorine fleet, four for Columbia Chemical and four for Southern Alkali.

The tanks are 64 ft. long and 8 ft. 9 in. in diameter. The four installed in each barge are separated by a solid transverse bulkhead, two tanks fore and two aft. They were fabricated by Blaw-Knox Co. and A. O. Smith Corp. Each tank has a capacity for 150 tons of chlorine.

Celanese Sets Up Chemical Engineering Award

AT THE formal opening of the company's central research laboratories at Summit, N. J., on September 22, Celanese Corp of America announced establishment of an annual Profession Progress Award in Chemical Engineering. It is the first major general award in that field and will be administered by the American Institute of Chemical Engineers. It will consist of $1,000 and a certificate.

CONVENTION CALENDAR

Pacific Chemical Exposition, Civic Auditorium, San Francisco, Calif., October 21-25.

Technical Association of the Pulp and Paper Industry, fall meeting on fibrous agricultural wastes, Alton, Ill., October 23-24.

American Association of Textile Chemists and Colorists, Congress Hotel, Chicago, Ill., October 23-25.

Federation of Paint & Varnish Production Clubs, Ambassador Hotel, Atlantic City, N. J., November 7-10.

American Institute of Chemical Engineers, annual meeting, Detroit, Mich., November 9-12.

National Fertilizer Association, Atlanta-Biltmore Hotel, Atlanta, Ga., November 10-12.

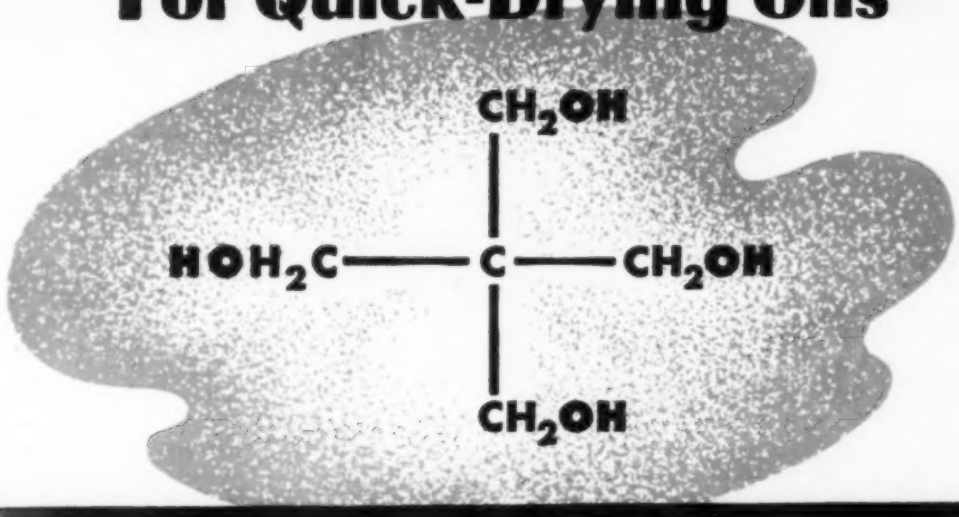
National Paint, Varnish & Lacquer Association, Ambassador Hotel, Atlantic City, N. J., November 11-14.

National Association of Insecticide & Disinfectant Manufacturers, Lord Baltimore Hotel, Baltimore, Md., December 1-3.

Exposition of Chemical Industries, 21st exposition, Grand Central Palace, New York, N. Y., December 1-6.

American Society of Heating & Ventilating Engineers, eighth international heating and ventilating exposition, Grand Central Palace, New York, N. Y., February 2-6, 1948.

For Quick-Drying Oils



PENTEK®

Pentaerythritol, Technical Grade

Pentaerythritol drying oils are noteworthy for

● Quick drying ● Quick bodying ● High gloss ● Water resistance ● Good aging qualities ● Hardness of film ● Toughness of film.

Pentek finds valuable application in coating compositions of alkyd, urea-formaldehyde, and modified phenolic resins . . . in plasticizers, emulsifying agents, and waxes . . . and as a glycerol replacement.

AVAILABILITY: 75-lb. multi-wall paper bags.

Technical literature will be sent upon request.

FINE HEYDEN CHEMICALS

HEYDEN CHEMICAL CORPORATION
393 Seventh Ave., New York 1, N. Y.
CHICAGO OFFICE, 20 North Wacker Drive
PHILADELPHIA OFFICE, 1700 Walnut Street

Electrochemical Society to Meet in Boston

ITS FALL convention will be held by the Electrochemical Society in Boston, Mass., on October 15-18. Presentation of papers on batteries will be presided over by John N. Mrgudich. The high temperature products session will be led by James H. Critchett. Two panels on preparation of chemical compounds by electrochemical processes will be steered by Ralph M. Hunter and N. M. Winslow. The session on electrochemical methods of laboratory control will be presided over by Eric A. Arnold.

The Society's retiring secretary, Colin G. Fink, will be honored by a testimonial dinner and dance on Thursday evening, October 16.

Timely topics of general interest will be treated by guest speakers at two of the luncheons. "Some Problems of the Nuclear Chain Reactor" will be the topic of J. B. Fisk, director of research for the U. S. Atomic Energy Commission, while Erwin D. Canham, editor of the *Christian Science Monitor*, will discuss "Our Pacific Frontier with Russia."

Higher Chemical Outputs Permitted In Germany

THE NEW level-of-industry plan for Germany set a production capacity ceiling for the US-UK zone of Germany equal to the industrial output for all of Germany for the year 1936. For the German basic chemical industries, this contemplates raising previous ceilings to a level five percent higher than in 1936, just prior to Hitler's drive to prepare German industry for war. Reason for bringing chemicals and several other industries above the 1936 level is that the US-UK zones, while representing Germany's greatest industrial potential, still will have to trade with other zones and other countries to lift its own production. And the higher levels for some industries, including heavy chemicals, will be used to foster this exchange.

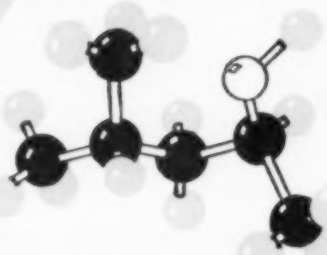
The revised plan is designed to permit the bi-zonal area to become self-sustaining and to contribute exports to the general recovery of Europe. It does not represent a production program, since production is governed by availability of fuel, power, raw materials, etc. What it does represent is an attempt to fix the amount of industrial capacity to be retained—and thus enable the authorities to go ahead with plans to identify plants in the zone for removal or reparations.

Figures from the joint announcement approved by the U. S. and Brit-

From SHELL CHEMICAL

METHYL ISOBUTYL CARBINOL

(Methyl Amyl Alcohol)



A colorless stable alcohol with a pleasant odor. Available in tank cars and drums

SPECIFICATIONS	
Purity	Min. 97.5% by wt.
Spec. Grav. 20°/20° C	0.807-0.809
Color	Max. 15 plat. cobalt (Hazen) standard
Water	Miscible without turbidity with 19 volumes of 60° Bé gasoline at 20° C
Acidity (other than carbon dioxide)	Max. .005% by wt. calculated as acetic acid
Distillation Range	Below 130° C: None Above 133° C: None

A request on your business letterhead will bring further technical information on Methyl Isobutyl Carbinol.

Among the many other Shell Chemical products are: Acetone, Methyl Isobutyl Ketone, Methyl Ethyl Ketone, Cyclohexane and Acrolein.

Here is a newly-developed solvent that can help *improve* surface coating formulations.

For example, high-purity MIBC is already contributing to better surface coatings manufactured by leading producers of industrial finishes:

Manufacturers of *nitrocellulose lacquers* find that MIBC improves diluent tolerance, viscosity characteristics, blush resistance and film flow.

In the formulation of *synthetic baking finishes* of the phenolic, alkyd or urea-melamine type, incorporation of MIBC yields solutions of low viscosity — promotes flow-out and prevents bubbling during baking operations.

OTHER IMPORTANT USERS OF **MIBC** INCLUDE:

THE MINING INDUSTRY: In conjunction with other frothing agents, MIBC improves metallurgical yields and renders recovery from low-grade ores by flotation processes more economical.

THE CHEMICAL INDUSTRIES: Undergoing the reactions typical of a secondary alcohol, MIBC is a raw material for the manufacture of resins, plasticizers, detergents, lubricating oil additives and xanthates as collectors in ore flotation.

MANUFACTURERS OF BRAKE FLUIDS AND CLEANING COMPOUNDS: Its solvent power for a wide variety of materials has established MIBC as a desirable medium-boiling constituent of solvent formulations.

SHELL CHEMICAL CORPORATION

100 Bush Street, San Francisco 6 • 500 Fifth Avenue, New York 18

Los Angeles • Houston • St. Louis • Chicago • Cleveland • Boston • Detroit

ish governments show what's contemplated in the revised plan for Germany's chemical capacity:

	Percent of 1936 Capacity	Percent of Existing Capacity
Synthetic ammonia	124	100
Inorganic chemicals	100	75
Misc. chemicals	97	38
Organic chemicals	100	71
Dyestuffs	96	98
Pharmaceuticals	84	87
Tar distillation	84	100
Chemicals, basic	105	98
Chemicals, total	98	54

The first level-of-industry plan provided for sharp cuts in the chemicals, metals, and machinery industries, but it was based on treating Germany as an economic unit. The new bi-zonal plan is based on the assumption that Germany will not soon become an economic unit (if ever), and hence the level of production in these industries must be raised over the levels set in the first plan. The revised plan actually calls for 42 percent more production of chemicals in Germany than the old plan called for. About 40-50 percent of German chemical capacity, including explosives, is to be destroyed or removed as reparations.

Other facts from the report: Plastics: production somewhat larger than prewar will be retained.

Dyestuffs: 34,000 tons capacity is to be retained. One plant of 2,500 tons capacity is to be available for reparations.

Pharmaceuticals: one plant will be available for reparations.

Prohibited Industries: the revised plan for synthetic ammonia, synthetic rubber, synthetic gasoline and oil, and ball bearing industries follows the original plan—they're to be eventually wiped out, but are being temporarily retained until Germany can import supplies of these materials. The aluminum, vanadium, and magnesium industries, which were to be wiped out, are now to be "reviewed"—the implication being that some productive capacity will be retained.

Chemical Market Research Group Meets

FIRST of the six meetings scheduled for the 1947-48 year was held on October 2, at Pittsburgh by the Chemical Market Research Association. Paul J. Carlisle, president, presided at the meeting. Dr. E. A. Weidlein, director of Mellon Institute of Industrial Research spoke on marketing products and research at luncheon session. Chairman of the afternoon session was Wilbert F. Newton who conducted a symposium that included a talk by E. J. Dowling, Diamond Alkali Co., on estimating markets. F. Juraschek, Carnegie Illinois Steel Corp., discussed knowledge of markets as the key to industrial planning. Eugene Ayers, Gulf Research and Development Co., spoke on the petroleum industry as a producer and consumer of chemicals.

Southern Alkali Buys Surplus Corpus Christi Plant

SOUTHERN ALKALI CORP. at Corpus Christi, Tex., is engaged on an extensive research and development program directed toward diversifying its manufactures to meet growing markets in the Southwest. The company has

Pilot plant spray dryer

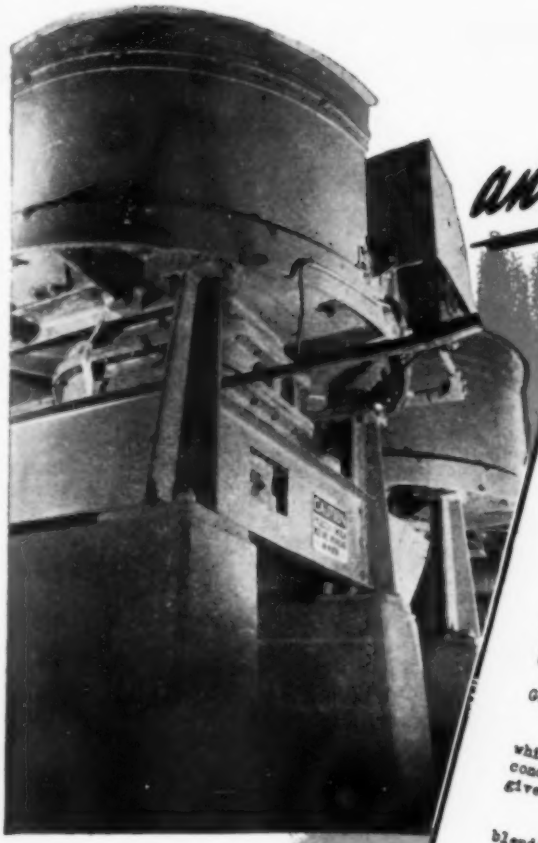
bought from War Assets Administration the properties, adjacent to its Corpus Christi plant, which American Cyanamid and Chemical Corp. used during the war to produce aluminum chloride for the petroleum industry, and is converting these properties into use by its Research and Development Department.

New Du Pont Sulphuric Acid Plant Starts Operations

THE NEW Du Pont contact sulphuric acid works at James River, Va., has started operations. Located 14 miles from Richmond, the newest Du Pont manufacturing unit is operated by the Grasselli chemicals department. It makes sulphuric acid for use by industries in the Richmond area. Andrew Sinnickson, of Philadelphia, formerly manager of the sulphuric acid works at Wurtland, Ky., is manager.

AEC Receives Report of Patent Advisory Panel

ATOMIC ENERGY COMMISSION has announced receipt of the first report of its Patent Advisory Panel, appointed last January, to recommend policy, procedures, and staff organization implementing the patent provisions of the Atomic Energy Act of 1946. The



another vote of confidence for SIMPSON MIXERS

THE J.R. WATKINS COMPANY
EXTRACTS SPICES PERFUMES SOAPS MEDICINES COSMETICS
WINONA, MINNESOTA U.S.A.

October 17, 1946

National Engineering Company
549 West Washington Blvd.
Chicago, Illinois

Gentlemen:

We are very much pleased with the engineering and laboratory work which your company recently completed for us. We are confident from tests conducted that the equipment recommended will save us considerable labor and give us a more uniform product than we previously had.

We heartily recommend this equipment where a fast and uniform blending operation is desired.

Very truly yours,
THE J. R. WATKINS COMPANY
Allyn M. Ramsden
General Supt.

Allyn M. Ramsden:HKB

Better, Faster Mixing . . . at less cost

Wherever you find Simpson Mixers handling dry, semi-dry or plastic materials, you'll find satisfied users . . . users who like the uniformly high product quality, increased mixing speed, and the lower production and maintenance costs made possible through the mulling principle of controlled mixing.

The money-saving features of Simpson Mixers are not just idle claims . . . they are job-tested and *proved* on hundreds of chemical process installations.

National Engineering service is yours for the asking. Write today.

Simpson Mixers are built in 10 sizes, from 1/5th to 50 cu. ft. capacity. Available with oil, steam or water jackets, for vacuum mixing, and also in corrosion-resistant materials.

SIMPSON Intensive Mixers

NATIONAL ENGINEERING COMPANY
604 Machinery Hall Bldg. • Chicago 6, Ill.

Manufacturers and Selling Agents for Continental European Countries—The George Fischer Steel & Iron Works, Schaffhausen, Switzerland. For the British Possessions, Excluding Canada and Australia—August's Limited, Halifax, England. For Canada—Dominion Engineering Co., Ltd., Montreal, Canada. For Australia and New Zealand—Gibson, Battle & Co., Pty., Ltd., Sydney, Australia

Panel concluded that the impact of the patent provisions is as small as possible consistent with the needs of common defense and security; that the normal incentives of the patent system are left open except for certain patents specifically bearing on atomic energy development, and that the Atomic Energy Commission is pursuing a policy of avoiding unnecessary interference with the normal functioning of the patent system.

The report charts the organization of the AEC Patent Section and reveals that to date some 5,500 items have been docketed in the form of invention records covering scores of different technical classes. Filing has been recommended in 2,300 cases. More than 9,000 project technical reports and 6,500 notebooks have been examined for evidences of invention. The Patent Section has accumulated a file of prior art patents which is complete in important fields in which the project is concerned.

New Sulphuric Acid Plant Operating at Spartanburg

INTERNATIONAL Minerals and Chemicals Corp. has started manufacture of sulphuric acid at the new plant at Spartanburg, S. C. The acid will be used in the manufacture of fertilizer in another plant which the company operates in Spartanburg.

Supt. A. L. Foster, stated that the new plant is one of the few of its kind in the South and was constructed from a patented design. The new plant will have a capacity of 20,000 tons of sulphuric acid annually.

General Chemical Buys Nitric Acid Unit

NITRIC ACID producing and handling apparatus and related production machinery and equipment at the Point Pleasant, W. Va., and Sandusky (Plum Brook), Ohio, ordnance plants have been sold to the General Chemical Co. of New York for $155,000 by the WAA. The company will remove the items from their present location and re-erect them in the General Chemical Co. plant in Newell, Pa.

Chemical Show to Feature New Developments

POST-WAR progress in the chemical industries will be reflected in the exhibits at the 21st Exposition of Chemical Industries at Grand Central Palace, New York, December 1-6. News from exhibitors indicates a trend in extremely difficult operating conditions, notably in the way of very high pressures and temperatures, and powerful

The DE LAVAL "Nozzle-Matic"

CONTINUOUSLY SEPARATES

TWO LIQUIDS AND A SOLID AND DISCHARGES ALL THREE . . .

● Put centrifugal force to work to speed up separation . . . clarification . . . concentration. The De Laval "Nozzle-Matic" makes it possible to run many processes continuously that were once slowed down by gravity or by less effective means of separating two liquids. Moreover, the "Nozzle-Matic" removes the solids present in the liquids, discharging them continuously.

The capacity of the "Nozzle-Matic" is high. It varies, of course, according to the nature of the materials handled. Some fluids or mixtures can be processed at a rate as high as 6,000 gallons per hour. Others must be separated or clarified at much lower rates . . . depending on results desired and the original mix.

The De Laval line of Industrial Centrifugals is large and complete. There is a machine for practically every problem where centrifugal force may be applied to advantage.

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, LIMITED, Peterborough

DE LAVAL Centrifugal Machines

. . . FOR PROCESSING SYSTEMS

corrosive effects. This indicates that many industrialists are considering ventures into new fields where intensive requirements predominate, making new demands on equipment.

The exposition will be one of the largest of its kind ever held, with an unusual variety of displays including industrial chemicals, chemical products, industrial materials and supplies of many kinds, in addition to the wide range of equipment specifically designed for the process industries. The roster of exhibits already accounts for all available exhibition space on the four floors of the Palace.

Contract Awarded for Coal Gasification Unit

CONTRACT for design and construction of its coal gasification pilot plant has been awarded by the Research and Development Division of Pittsburgh Consolidation Coal Co. to the Chemical Plants Division of Blaw-Knox Co.

Construction on the $500,000 plant will get under way late this year. When completed, the pilot plant, to be located at Library, Pa., near the coal company's research center, will generate approximately 1,000,000 cu. ft. of synthesis gas per day.

Oil Chemists to Hold Fall Meeting in Chicago

PRESENTATION of 36 technical papers will highlight the 21st fall meeting of the American Oil Chemists' Society on October 20-22 at the Edgewater Beach Hotel in Chicago, Ill. Symposia will embrace soap and glycerine; drying oils, reversion, stability, oxidation, and antioxidants; and processing methods. In addition, there will be general papers on fats and oils.

Presiding at the meeting will be R. T. Millner of Peoria, Ill., head of the Society. Chairman is G. A. Crapple of Wilson & Co., Chicago; program chairman, H. C. Black of Swift & Co., Chicago.

The vitamin committee, of which N. D. Embree of Distillation Products, Inc., Rochester, N. Y., is chairman, will hold two public meetings, on October 22 in the afternoon and October 23 in the morning.

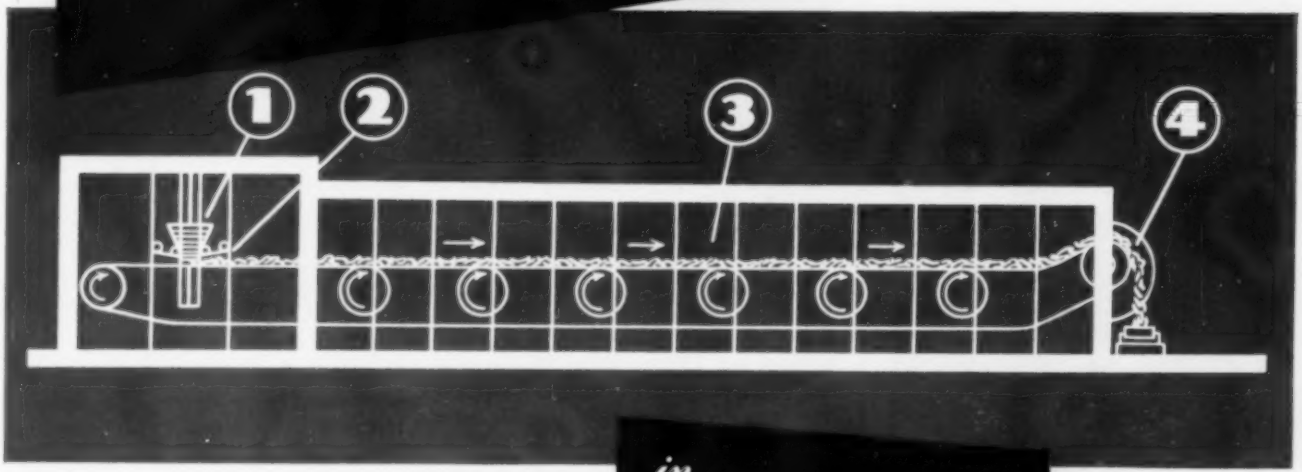
Ammonium Sulphate Sold on Three Year Contract

ENTIRE output of ammonium sulphate for the next three years from the Daingerfield, Tex., plant of Lone Star Steel Co. will be purchased for the manufacture of mixed fertilizer by the Jacksonville Fertilizer Co. of Jacksonville, Tex., according to an announce-

ZINC OXIDE

REDUCED TO 0.25% (B.D.W.B.*) MOISTURE CONTENT AT RATE OF 1,830 POUNDS PER HOUR

*BONE DRY WEIGHT BASIS



in

PROCTOR

Continuous Conveyor System

Tonnage production of thoroughly, uniformly dried zinc oxide was converted from a production dream into a reality with the installation of a Proctor continuous conveyor drying system, combined with a preforming feed.

Here is how the Proctor system operates in the handling of zinc oxide. ❶ Having been mechanically dewatered by means of a continuous filter, the still highly moist zinc oxide is deposited into the hopper of a Proctor rolling extruder feed. ❷ In this rolling extruder feed, the material is forced through a perforated plate by rolls moving back and forth and deposited in spaghetti-like extrusions onto the conveyor of the dryer. This particular type of preforming feed is used because the physical characteristics of the zinc oxide are such as to permit it holding a definite shape after extrusion. ❸ Entering the dryer, with a moisture content of 69.5% (B.D.W.B.), these extrusions of zinc oxide lie in a bed on the perforated plate continuous conveyor of the dryer. The shape of the uniformly thick extrusions makes it possible for heated air at a temperature of 275°F. to circulate *through* the bed of material—thus promoting rapid diffusion and subsequent speedy, thorough and uniform drying. ❹ After 105 minutes of drying time, the extrusions of zinc oxide are discharged with a moisture content of 0.25% (B.D.W.B.)—uniformly dried at the rate of 1,830 pounds per hour (C.D.W.).

This installation represents one more instance where Proctor engineers converted facts gathered in the laboratory and translated those facts into a drying system that is meeting a specific need in the chemical process industries. Each Proctor system is individually designed to meet individual product and plant requirements. If drying is a part of your plant operation, you may be pleasantly surprised at what an individually designed Proctor drying system can do for your production. Consult Proctor engineers without obligation.

PROCTOR & SCHWARTZ, INC.

PHILADELPHIA 20, PA.

A new 12-page booklet on "Proctor Continuous Drying for the Chemical Process Industries" is available upon request. It contains many case studies showing the application for Proctor individually designed systems. Write for your copy of this informative booklet today

This laboratory is a new addition to the San Antonio headquarters of Southwest Research Institute

ment from the Washington office of Representative Tom Pickett (D., Tex.). The ammonium sulphate capacity of Lone Star, which began operations last July, is about 30 tons per day. The Jacksonville company, which has been renamed the Carlisle and Killingsworth Brokerage Co., is expected to increase its daily output from the present 100 tons to 200 tons as a result of the new ammonium sulphate supply.

Traditional Breakfast Is Scheduled for Gas Men

COINCIDING with the holding of the National Metal Congress and Exposition in Chicago, October 18-24, the Industrial and Commercial Gas Section, American Gas Association, will hold its traditional Industrial Gas Breakfast on the morning of October 22 at the Hotel Stevens.

Phthalic Anhydride Output To Be Doubled by Oronite

A PLANT EXPANSION program which will double its present production rate of phthalic anyhydride at Richmond, Calif., has been announced by Oronite Chemical Co., San Francisco. Construction is now ready to start, states George L. Parkhurst, president of Oronite, and the increased output will be available during the first half of 1948.

First operated in early 1946, the eight-converter Oronite unit was the first commercial producer of phthalic anhyride in the West and the only plant of its kind to use petroleum-derived ortho-xylene instead of naphthalene as the basic raw material (see *Chem. Eng.*, August 1946, p. 116-119). Principal present market for phthalic anhydride is as a base for alkyd resin paints, production of which is rapidly expanding on the Pacific Coast.

Southwest Research Institute Plans Houston Laboratory

PLANS FOR the establishment in Houston, Tex., of a $1 million branch laboratory to be devoted to chemical research and technology in petroleum have been announced by the Southwest Research Institute. The announcement was made in September at the dedication of the Institute's San Antonio headquarters. W. M. Hammond, former business manager of the Armour Foundation, is acting director of the Institute.

Establishment of the laboratory in Houston was decided upon because of the extensive petroleum production and refining activities near Houston and along the Texas Gulf Coast. Site for the laboratory had not been selected several weeks ago. It is considered that construction will start in about six months. Approximately 20 technologists will be employed. In accordance with the Institute's established practice, research and development will be performed by the laboratory at cost, the sponsor of each project obtaining ownership of any patents that may result from the project.

The Institute is establishing an office in the Oil and Gas Building in Houston where a representative will acquaint Gulf Coast industries with the services of the Institute and discuss the merits of contemplated projects with company officials.

Armour Research Locates Rare Chemicals

IF YOU NEED rare chemicals, get in touch with the National Registry of Rare Chemicals at the Armour Research Foundation, 35 W. 33rd Street, Chicago. Within the last few months, the registry has located hundred of hard-to-find compounds. In fact, the registry's only function is to provide

a free service in tracking down rare chemicals for industry, educational institutions and other users engaged in confidential research. The registry was established in 1942 to provide scientists all over the world with a central clearing house of information on the availability of chemicals not normally stocked by supply houses. It proved its worth during the critical war years and is continuing to demonstrate its value during peacetime.

Industry Briefs

Eighth Pittsburgh Conference on Applied Spectroscopy sponsored by the Spectroscopy Society and the University of Pittsburgh will be held Thursday to Saturday, November 13 to 15, 1947, at the Mellon Institute Auditorium. As in the past, sessions on both emission and absorption spectroscopy are planned.

Carleton Shugg, general manager of Todd Shipyards Corp. in charge of New York Harbor work, has been named manager of the Hanford Directed Operations of the United States Atomic Energy Commission, with office at Richland, Washington.

Helena Cotton Oil Co. has completed at Helena, Ark., a $320,000 plant for solvent extraction of cottonseed oil. Daily capacity of the unit, which was installed by Allis-Chalmers, is 200 tons of cottonseed. Hexane is the solvent employed.

READERS' VIEWS and COMMENTS

Correction

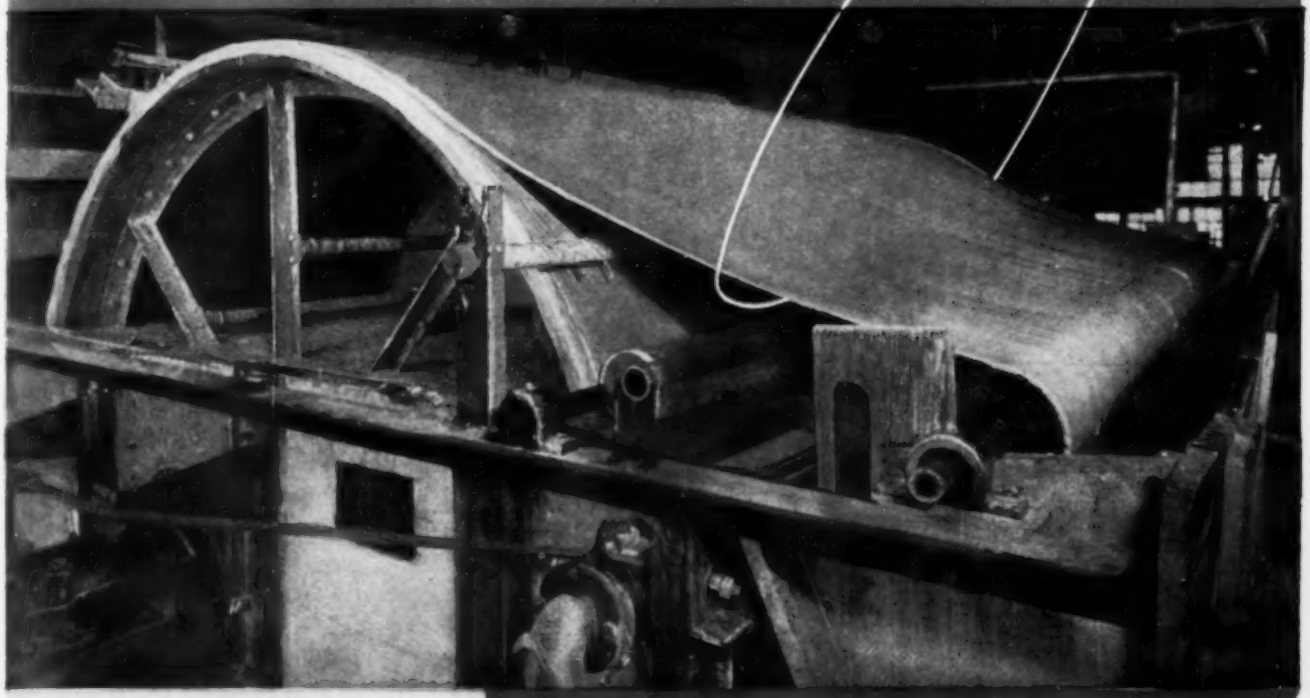
A COMPUTATION error has been called to our attention in Table VIII of the article on cost of magnesia insulation, appearing on p. 128 of our September 1947 issue. Under Fuel Gas, 600 B.t.u. per Cu. Ft., the prices per 1,000 cu. ft. should have been derived from the prices per million B.t.u. by multiplying by 0.6, whereas they were obtained by dividing by this factor, so that they are 2.78 times too large.

Equipment Costs

To the Editor:

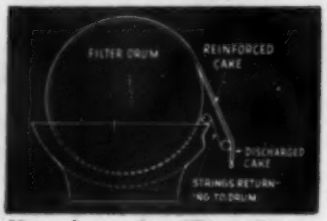
Sir:—Congratulations are in order for the fine start on furnishing data for process equipment cost estimating. I, along with others, hope that from time to time reprints of collections of

LIFT THE FILTER CAKE WITH STRINGS...



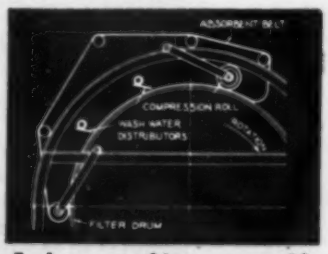
AND LOWER YOUR COSTS WITH THE FEinc FILTER

STRING DISCHARGE



Note how the FEinc String Discharge reinforces the filter cake and removes it from the filter drum in one continuous, easy-to-handle sheet.

BETTER WASHING



A long washing arc, with thorough flooding of the cake followed by a long dewatering cycle, results in better chemical washing.

OTHER FEATURES

Compression Drying Mechanism
Continuous Filter-Drum Dryer
Repuddling Process for Starches
Scoring Device for Feeding Preformed Cake to Continuous Dryers

You don't have to put up with frequent cloth changes, "blow-back", wire winding, or scraper-clogged filter cloths that are too heavy for good continuous filtration.

With the FEinc continuous rotary vacuum filter, the String Discharge lifts the thoroughly dewatered filter cake gently from the revolving filter drum—in one continuous sheet with no scraping. . .

As the filter rotates, the filter cake is deposited over a series of closely spaced, endless strings that pass around the drum. The strings reinforce the cake as it comes off the drum, and support the cake to the small-diameter discharge roll where the strings are disengaged and passed back to the filter drum.

FEinc filters are normally available in sizes from 9 to over 500 sq. ft. filter area. Plain designs handle the "easy" jobs, and any combination of the exclusive FEinc features can be adapted to your special filtering, washing, drying, and cake-handling problems. Call in Filtration Engineers Inc. to help you plan for better continuous filtration.

Bulletin 101 rushed on request.

FILTRATION ENGINEERS INC.

858 Summer Avenue • Newark 4, New Jersey

In Canada: The Northern Foundry & Machine Co., Ltd., Sault Ste. Marie, Ontario

the shorter, subsequently published articles will be made available.

As a minor contribution to this subject, here are a few spot equipment cost data which have been obtained recently:

1. Balls for ball mill, Jan. 1947, 2-in. dia. Mn steel balls, $117 per ton f.o.b. Denver.

2. Rubber lined tanks, April 1947, $\frac{3}{16}$-in. thickness rubber, $2.50 per sq. ft., cost of metal vessel not included. Openings, $5-20 extra for each, i.e., $5 for small openings, $20 for manholes.

3. Rubber lined piping (subject to 25 percent discount).

Dia., In.	Cost Rubber Lined pipe	Cost Rubber Lined Flanges
2	$1.85 per ft.	$11.70 per pair
3	3.80	18.30
6	5.90	27.20
8	8.00	34.20

For example, a 10-ft. length of 2-in. flanged pipe would cost $18.50 + 11.70 = $30.20.

4. Chlorine tank cars: single units.

1944.....	55 ton	$10,000
1944.....	30 ton	6,500
1944.....	15 ton	5,500
1947.....	30 ton	7,200

1947 multi-unit, 15 1-ton containers, frame cost = $2,500, containers = $200 each, total = $5,500.

The following is evidence, in one case at least, of the validity of estimating the cost of rubber-lined steel tanks. A 20,000 gal. steel tank, 10 ft., 6 in. diameter, 31 ft. long, of $\frac{1}{4}$ in. thick plate weighs 14,100 lb. At $0.15 per lb. the steel tank cost was estimated to be $2,115. One manhole and three pipe openings were estimated as an additional $200. On the basis of the costs given above, the rubber lining will cost $3,060 plus $50 for lining the openings. Total estimated cost is then about $5,500. A quotation submitted by a manufacturer for the above 20,000 gal. tank was $5,300.

C. A. Hampel
Armour Research Foundation
Chicago 16, Ill.

Addenda

Attention has been called to our inadvertent omission of several associations from the listings of technical societies published in the July (p.234) issue of *Chemical Engineering*. The following should be added:

American Society of Refrigerating Engineers. Acting Sec., M. C. Turpin, 40 West 40th St., New York 18, N. Y.

Calcium Chloride Association. Managing Director, George H. Kimber, LaSalle Bldg., 1028 Connecticut N.W., Washington 6, D. C.

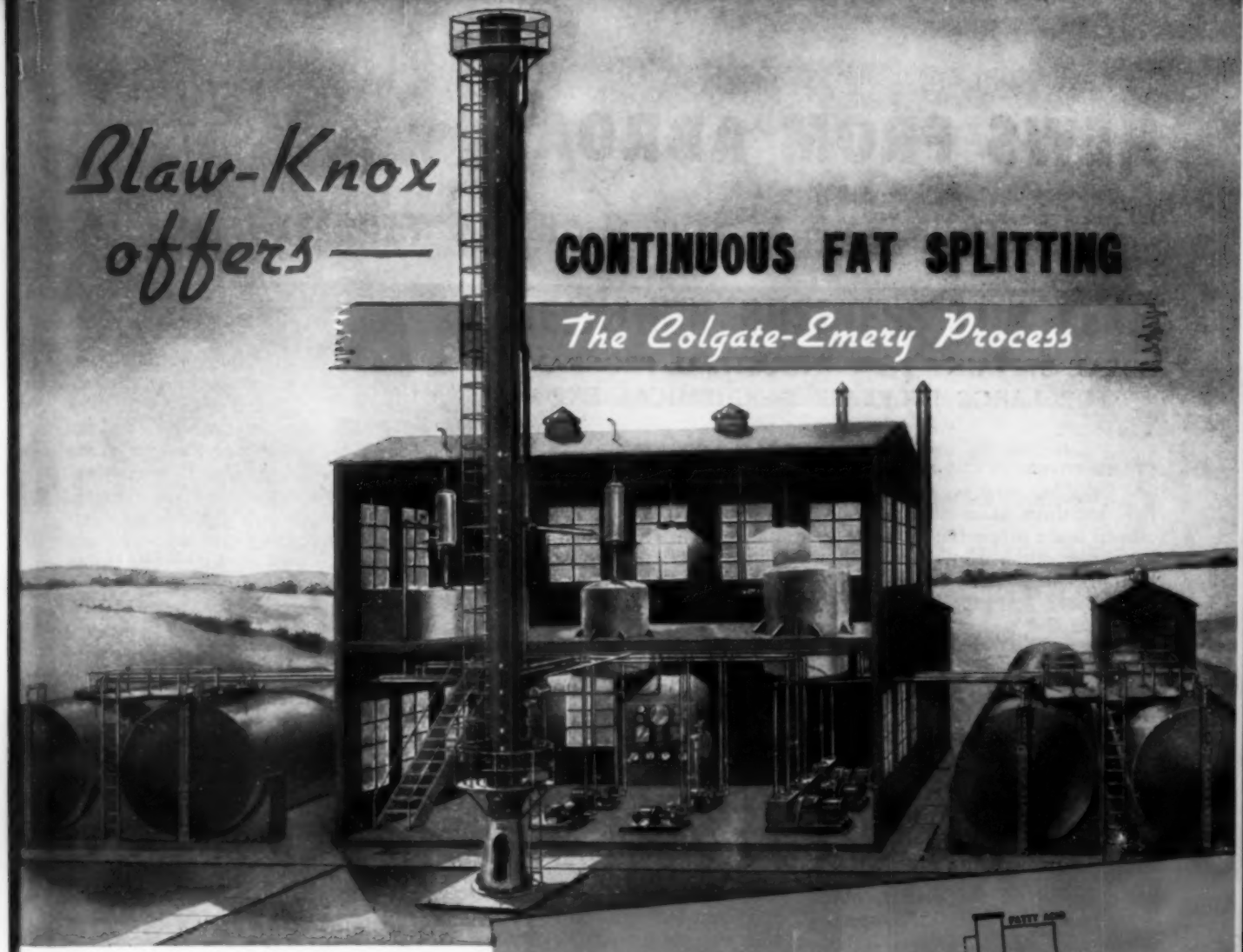
Forest Products Research Society. Sec.-Treas., Thomas R. C. Wilson, P. O. Box 2010, University Station, Madison 5, Wis.

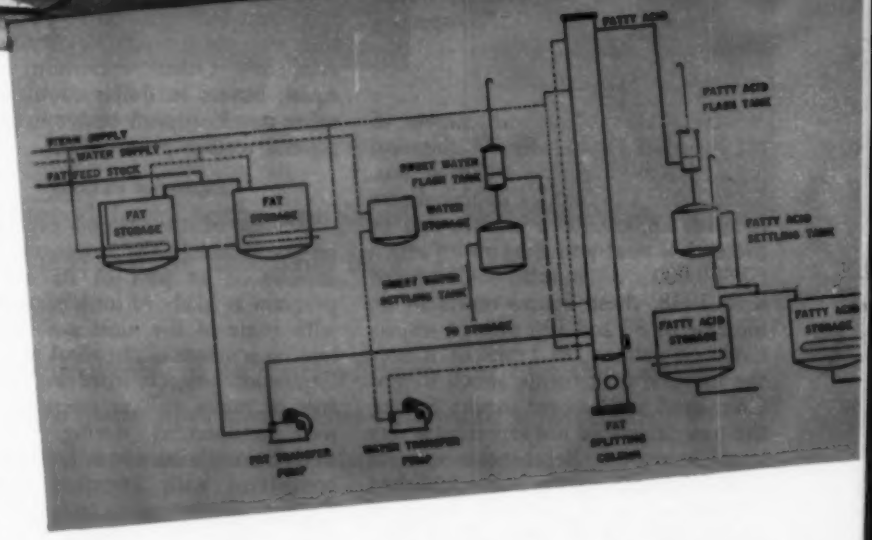
Instrument Society of America. Exec. Sec., Richard Rimbach, 1117 Wolfendale St., Pittsburgh 12, Pa.

Sugar Research Foundation. Exec.-Director, Neil Kelly, 52 Wall St., New York 5, N. Y.

Blaw-Knox offers — CONTINUOUS FAT SPLITTING

The Colgate-Emery Process





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NEWS FROM ABROAD

Special Correspondence

GREAT BRITAIN'S NEW INDUSTRIAL PROGRAM CALLS FOR LARGE INCREASE IN CHEMICAL EXPORTS

THE GOVERNMENT'S anti-crisis program has now been disclosed in full. Its three main planks are: increased home production of dollar-saving commodities, reduced expenditure on long-term projects, and bridging of the import-export gap by cutting down purchases and raising sales in foreign markets. The chemical industries will be affected by all three measures, but first impressions are that none of them will seriously interfere with the normal flow of business. The tone of the chemical markets remains steady. Expectation of a falling-off of unessential demand has been more than offset by the possibility of price advances to make up for dearer coal and transport. If uncertainty has kept some buyers off the market, others have rushed in to cover prospective needs.

Export Targets

New "realistic" export targets of the Board of Trade leave the chemical industries more or less where it was. By mid-1948 exports of chemicals are to reach £6,850,000 a month, and by the end of next year they are to attain £7,500,000 a month. Compared with 1938, these figures represent an increase by 88 and 106 percent respectively in volume; in terms of money the increase is of course much bigger. Compared with recent export figures, the new targets do not represent a very large increase. Before the end of 1946 chemical exports had established themselves on a monthly basis of £6,000,000. In the first half of 1947 the monthly average fell to just over £5,000,000, largely owing to fuel and power cuts in February and March, but, more recently, export trade has recovered steadily, and in July, always an exceptionally good month, chemicals to the value of £7,170,000 were shipped abroad. This no doubt was followed by a decline in August, but even so the chemical industry is well on the way to reaching the new export targets.

To make sure that individual firms and industries pay proper attention to the export market, the Board of Trade will withdraw materials and labor from those unable to sell their export quota "unless new and appropriate markets abroad can be found". This presumably means that attainment of the export target alone is not enough and that the destination of exports also will be borne in mind. Such a policy follows the lines indicated earlier in these columns but does not necessarily involve compulsion. A complex export licensing system is to be avoided; "general control by agreement" is to take its place. As the export targets have been fixed in consultation with industrial organizations, so the practical side of export promotion will be left largely to private arrangement, and industrial quarters hope that in this way unnecessary rigidity will be avoided. Other conditions being equal, buyers in dollar countries and other non-European customers will in general receive priority.

Expansion Projects

Review of the capital expenditure program which the government has announced as part of its anti-crisis program is likely to interfere seriously with some of the most ambitious extension schemes of chemical producers. Expansion projects involving expenditure of many million pounds sterling were announced during the past twelve month by virtually all the big companies with chemical interests. Though the extension and modernization program of Imperial Chemicals with its estimated cost of £40,000,000 towers head and shoulders above all others, several oil companies, the leading fertilizer combine, the big rayon producers, rubber and alcohol interests have announced expansion schemes quite as ambitious in relation to their smaller means and fields of activity, to say nothing of similarly extensive projects in the metallurgical and coal processing industries which are of direct interest to the chemical trades.

Some of these will be cut drastically, as the government prefers exportation of capital goods now to their installation in factories which will not reach the productive stage for some years to come. Although there is reason to believe that chemical industries will be dealt with gently when "substantial reduction in the flow of new machinery and equipment to British industries" is made, a good many extension schemes will have to be postponed. This enforced postponement already has been anticipated by some of the most progressive firms which are now making efforts to raise production by intensified use of existing plant.

Increased Demand

From the export targets fixed for other industries it appears that the government expects special efforts from manufacturers of woolen textiles, rubber goods, vehicles, leather articles, machinery, rayon, and footwear. All these industries are big consumers of chemicals. While it is true that part of the desired export expansion will be obtained by keeping home sales down to a minimum, demand for chemicals from these industries is certain to increase. Dyes, rubber chemicals including such imported commodities as sulphur and carbon black, and the numerous products needed for making synthetic fibers and processing wool and leather will be needed in larger quantities to fulfill the bigger export programs. On the other hand, any cutting-down of capital expenditure, chiefly on new building and construction, will react on sales of paints and chemicals needed in glass making.

Increased reliance on home-produced food, another of the government's chief policies, will demand the supply of more fertilizers and pest control agents by chemical manufacturers. The quantities involved are not yet known, but they will no doubt be substantial. Direction of labor and raw materials away from unessential uses may, on the other hand, reduce demands from cosmetics makers and certain other luxury trades. Altogether the chemical industries will have to make substantial re-adjust-

Turbo-Topics

SOLVING DIFFICULT MIXING PROBLEMS IN INDUSTRY HAS BEEN OUR BUSINESS FOR YEARS

PENICILLIN—Turbo-Mixer of Inconel in fermenter at Cutter Laboratories, Berkeley, California.

The three illustrations shown are typical of the variety of difficult problems of mixing liquids with liquids, solids and/or gases successfully solved by the Turbo-Mixer technique.

PHOSPHORIC ACID — Lead covered Turbo-Mixers in strong acid leach tanks with Atlas Mineral Products' "Rewbon" brick lining.

SYNTHETIC LEATHER — Battery of Turbo Nitro-Cotton Dissolvers preparing the synthetic leather base.

The fact that each mixing problem is treated individually, and approached from the chemical engineering viewpoint by men specially trained in interpreting and applying data, gathered from many unrelated industries, accounts to a large extent for the unusually high percentage of repeat orders received.

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ments to fit in with the program. In more than one field exports and home demands clash, and it will not be easy to arrive at a tolerable compromise.

Soapless Detergents

Interest in soapless detergents has been stimulated by the knowledge that world shortage of vegetable oils and fats will continue for several years. Not only the leading oil producers, but also manufacturers of traditional types of soap have studied the existing opportunities and come to the conclusion that there is limited scope for further expansion. The supply of necessary materials for the manufacture of soapless detergents is a limiting factor, but apparently shortage of containers is more serious as detergents can be produced only in the form of powders, pastes and liquids. Special interest therefore is attached to the report that a license has been granted by the Ministry of Food to a soap research firm for the manufacture of a fatless synthetic household soap in tablet form.

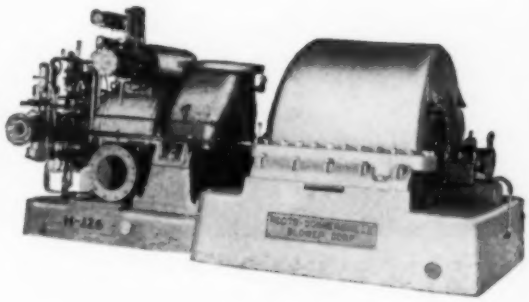
First major unit of the Atomic Research Establishment of the Ministry of Supply at Harwell, Berkshire, came into operation at the middle of August. It is a graphite low-energy experimental pile which at first will be used for production of small quantities of radio-active materials for biological and medical research. Later, when the more powerful Harwell pile comes into operation, probably some time next year, the smaller pile will be used for experimental work in nuclear physics. The first pile to be completed is a combined achievement of scientists from various parts of the British Commonwealth. It was designed largely by a New Zealand team of scientists, but many English scientists contributed to the production of pure graphite and uranium, and considerable assistance has been obtained from Canada, particularly in the testing of graphite.

Penicillin Factory

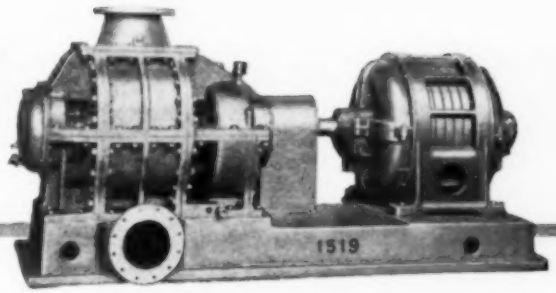
The penicillin factory at Speke, Liverpool, destined to become the biggest of its kind in the world, has been handed over by the Ministry of Supply to the Distillers Co. Ltd. which previously operated the £1,125,000 plant on behalf of the Ministry. The company intends to increase production on a commercial basis, maintaining the factory as the principal center of manufacture for home and export purposes; at present production is believed to run at a monthly rate of 80 billion units. Distillers Co Ltd. also is setting up a pilot plant for streptomycin which is

EQUALLY GOOD

at pushing



or pulling



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Prospective purchasers and visitors examine the latest line offered by a manufacturer of chemical laboratory equipment on exhibit at the Fall Fair held in Leipzig. This was the first Fall Fair held in that city since the war and exhibits included products from the four occupation zones in Germany

expected to be in use about the end of 1947. In the meantime Glaxo Laboratories Ltd. which is making streptomycin has been requested by the Ministry of Supply to strive for a higher output. Every assistance has been promised to speed up building work on the Glaxo plant at Ulverston, Lancashire, following favorable reports on clinical trials by the Medical Research Council.

New Linseed Oil Plant Going Up at Toronto

WORK has started on the erection of a new linseed oil plant at Toronto. The plant will have a daily oil capacity of 200,000 lb. and will be owned and operated by Toronto Elevators Ltd. of Toronto. Construction is under the direction of Blaw-Knox Co., Pittsburgh, Pa.

CHEMICAL PRODUCTION IN CZECHOSLOVAKIA GEARED TO TOP THE VOLUME TURNED OUT IN 1937

CHEMICAL INDUSTRY in Czechoslovakia is fulfilling its part of the Republic's Two Year Plan by only 88.5 percent, as compared with 101 percent reported for industry as a whole, and thus is one of the major headaches for Czech administrators. The industry is one of the key sections of the Republic's economy, as it has to produce materials for almost all other industries in their planned expansion.

The Two Year Plan, to which all Czech industry is geared, it designed to bring the country's industrial output up to 110 percent of 1937 production by the end of next year. This plan began on January 1, 1947. The chemical industry, as one of the lagging groups, is being exhorted to make up, in the latter part of the year, the leeway of the first eight months. Exhortations, however, are no substitute for raw materials which are definitely short, particularly crude oil and fatty acids.

The government has not attempted to make nationalization of the chemical industry complete. It is today about 72 percent nationalized; this includes synthetic motor fuel and oils, rubber and tires, production of basic inorganic and organic chemicals, as well as most of the pharmaceuticals and a wide range of production from matches to artificial fertilizers.

Among the branches not nationalized are technical gases, soap, household cleaners, cosmetics, accessories for textiles and leathers, dyes, fine chemicals, dental and surgical appliances, plastics, varnishes and lacquers, composition roofing, glue, office requisites, photographic materials, building accessories, tarpaulins, insecticides, fungicides and chemicals for plant protection.

The nationalized industries comprise six national undertakings in the "Czech lands" of Bohemia and Moravia and four in agrarian Slovakia, the industrialization of which is a key part of the Two Year Plan. Head Office of the nationalized chemical

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- . . . *or the case of the pulp mill that ran its screen rejects into the river until a Sprout-Waldron Refiner began converting those rejects into useable paper pulp.*
- . . . *or the egg dehydrating plant faced with the disposal of mounting tons of shells. A Sprout-Waldron installation was devised to transform this obnoxious waste into valuable by-products.*

These are but three examples of Sprout-Waldron ADAPTIONEERING and the value of this ADAPTIONEERING service is concretely illustrated by more than 7,000 samples of Sprout-Waldron's actual project experience — accumulated and filed for your reference and assistance.

If you reduce the size of any material, mix one material with another, or handle any material in bulk, you may realize considerable savings by consulting Sprout-Waldron.

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Manufacturing Engineers

industries is the Czechoslovak Chemical Works, National Corp., Prague, with a regional office in Bratislava. This central organization buys basic raw materials and directs the sale of finished products for the whole sector.

The capital works and equipment program would make over-heavy demands on the engineering industry if begun immediately so the new industrial equipment program is staggered so as to reach completion at the end of 1948 or the beginning of 1949.

In addition to production of synthetic petrol, Czechoslovakia is producing petrol from crude oil, in order to provide home-produced lubricants. Crude oil is to be mostly imported, but the aim is to develop the small oil wells in Southern Moravia and Slovakia. Scheduled targets for lubricants from mineral oils is to reach 130 percent above the 1946 figure by the end of 1948. Production of benzol and its homologues is planned to reach 160 percent of 1946 production.

Production of nitrogenous fertilizers for 1947 is set at 129,000 tons. This estimate appears to be being met satisfactorily, and during the first seven months, 75,085 tons were produced, 101.7 percent of the planned output to that date.

Phosphate Fertilizers

The target for phosphate fertilizers is 380,000 tons annually. In the first seven months 184,484 tons were produced. This is only 84.3 percent of the plan, but the general management of the industry claims that demands of agriculturists are being fulfilled, and that production was deliberately held back when seasonal demands were not so great, in order that sulphuric acid urgently required for coke ovens and the metallurgical industry could be switched over.

Production of sulphuric acid has met with constant difficulties due to obsolete plant which had not been renewed during the years of German occupation. Planned annual production of 205,000 tons has been met to the extent of 106,429 tons, 97.4 percent, for the first seven months.

The main plant which produced bichromates was in such a bad state when the plan was begun that, in spite of constant repair, frequent stoppages occur. In May the plant was able to operate only 18 days. This branch only produced 79.9 percent of the planned output for the first seven months.

Production of soda ash at 102,000 tons annually, has been met to the extent of 92.1 percent—50,563 tons for the first seven months. Lack of salt held up production in the first few months, but regular supplies are

Pumping from lake or river?
. . . with icing in winter?
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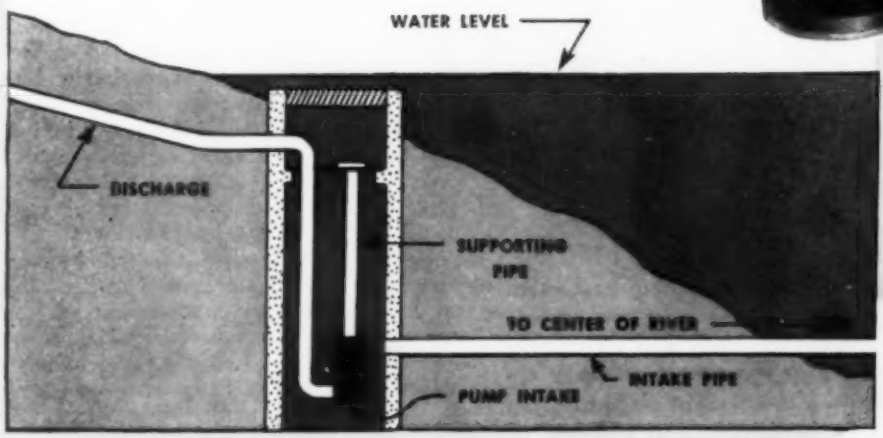
SUBMERSIBLE RIVER INTAKE PUMP



This small Submersible River Intake Pump delivers river water at 100 gpm against a 55 ft. head. Consistent water delivery in spite of 40° below zero North Dakota Winter temperatures and Spring high water 45 feet above the pump intake.

CAPACITIES: to 5000 gpm
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INSTALLATION: Vertical, Horizontal, or on an incline

Down at the bottom of the river or lake it doesn't matter about ice or high water. That's why the Submersible is the logical solution to this kind of pumping problem. It operates regardless of surface conditions.

Sealed oil-filled submerged motor is close-coupled direct to pump (pump can be any one of several different types).

Starting panel (equipped for manual or automatic starting) can be located at any convenient point above flood stage. Discharge pipe should be buried enough to eliminate freezing.

Many other advantages. Easy to install. Simplified intake structure. No adjustments. No pump house. Operates for months without attention. Safe against vandalism.

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now coming from Germany, Austria, the USSR and Poland, and production has been on the increase. The same applies to sodium hydroxide, which over the first seven months, has reached only 84.8 percent of the planned figures.

Lack of raw materials, mainly linseed oil, resins and solvents, keeps production of paints and varnishes down to 96 percent of the plan, but the critical lack of fatty acids is most noticeable in production of soaps and soap powders at 66 percent and 82.9 percent respectively, as well as textile and leather accessory products where the output has only reached 53.6 percent and solvents, 74.4 percent. These branches can hardly be expected to attain the planned production figures, certainly not in 1947.

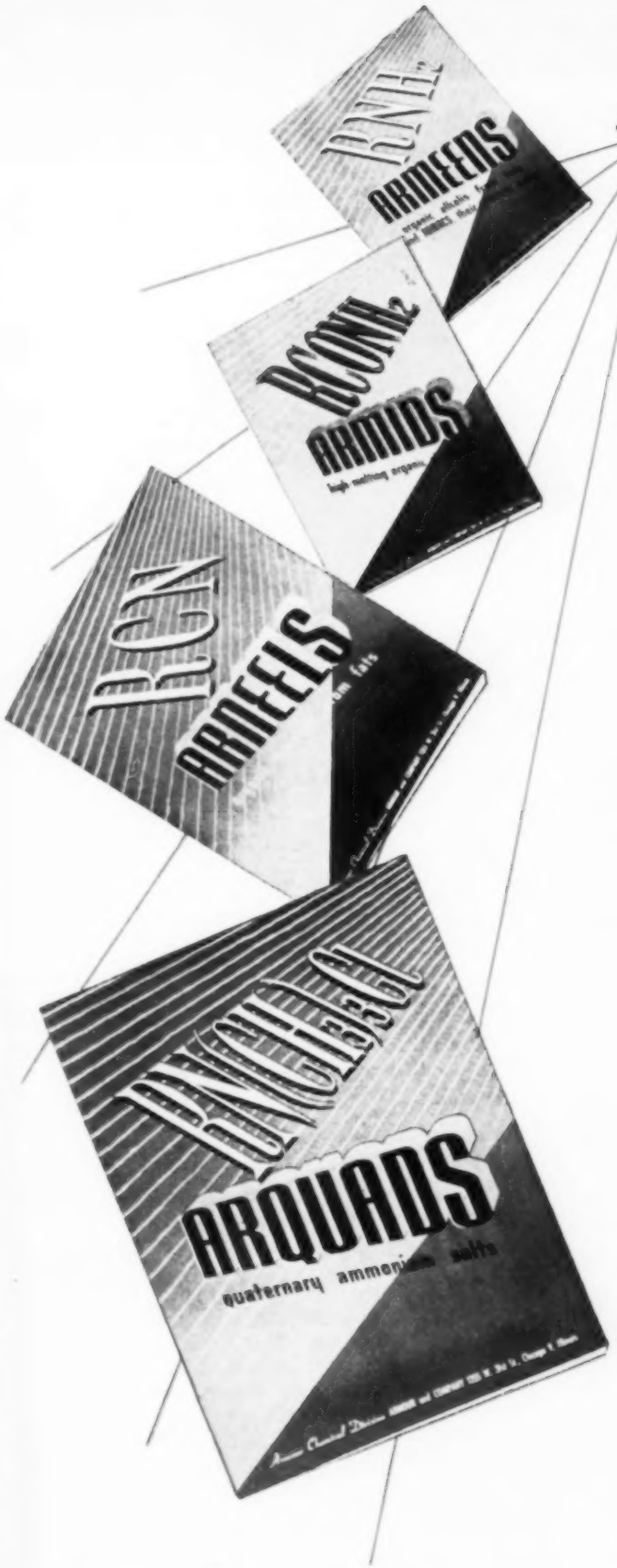
Potash producers, however, are optimistic that their low output, 65.4 percent, due again to lack of raw material, will come up to scratch by the end of this year.

Czechoslovakia is actively combing all markets for the purchase of raw materials. Under the new agreement with Roumania they are to receive naptha. Recently some dozens of "praga" lorries were sent to Hungary in exchange for valuable raw materials. Under the Czech-Soviet commercial treaty, the Soviets will suply Czechoslovakia with potassium salts, mostly potassium chloride, of which 40 percent will come from the Soviet zone of Germany and 60 percent from the USSR direct. Other raw materials include industrial salt, sulphur, turpentine, sulphuric acid and various fuels, as well as an important consignment of apatite concentrates needed for production of phosphate fertilizers. Edible fats and oils are being imported from the United States, USSR, Roumania, and Bulgaria.

A delegation from the Czechoslovak chemical industry recently went to Poland to discuss cooperation. Commercial competition between the two countries will be dropped, and a common commercial policy is to be followed in world markets. Branches of the chemical industry which are specially successful in Czechoslovakia will not be set up in Poland and vice versa, and common research work will be undertaken. It is expected that the Czech chemical industry will go even further afield in this respect.

Soviet Monthly Devoted To Chemical Enginering

THE ORGAN of the Soviet Ministry of the Chemical Industry is a monthly magazine "Khimicheskaya Promyshlennost" (Chemical Industry). Com-



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Among the present uses are: as industrial germicides, fungicides, and disinfectants; alkaline cleaning compounds; water-treating chemicals; ore flotation reagents; anti-static polishes for plastics; cationic emulsifiers and detergents; textile softeners.

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parable in page size and format to *Chemical Engineering*, except that it is about half an inch wider, the magazine contains about 30 pages of reading material.

Text is almost solid printed matter enlivened somewhat by illustrations; rarely photos, more frequently charts, diagrams, drawings, formulas and tables. Like most Soviet publications, the magazine carries no advertisements. Back cover is blank, except for the price, eight rubles a copy. Front cover is devoid of color, having only the name, year and number of issue, and the emblem of the State Chemical Publishing House which prints the magazine.

Contents of an average issue consist of five to eight major articles which may be from one to seven or more pages long. The articles are devoted to current problems of chemical engineering in the Soviet Union. Every issue devotes from six to ten pages to foreign chemical news and to abstracts from foreign chemical periodicals.

Caustic Soda Critically Short in Australia

COAL and shipping shortages affecting output and deliveries from Imperial Chemical's South Australia Alkali plant and a ten-month-old strike of maintenance men at the company's Botany, New South Wales, establishment have plunged Australian industries dependent on caustic soda into a crisis.

The price of "Burry" wool which must undergo a process of "carbonization" and subsequent treatment with the hydroxide before it can be spun has dropped to next to nothing. Soaps and scouring agents are scarcer than at any time during the war.

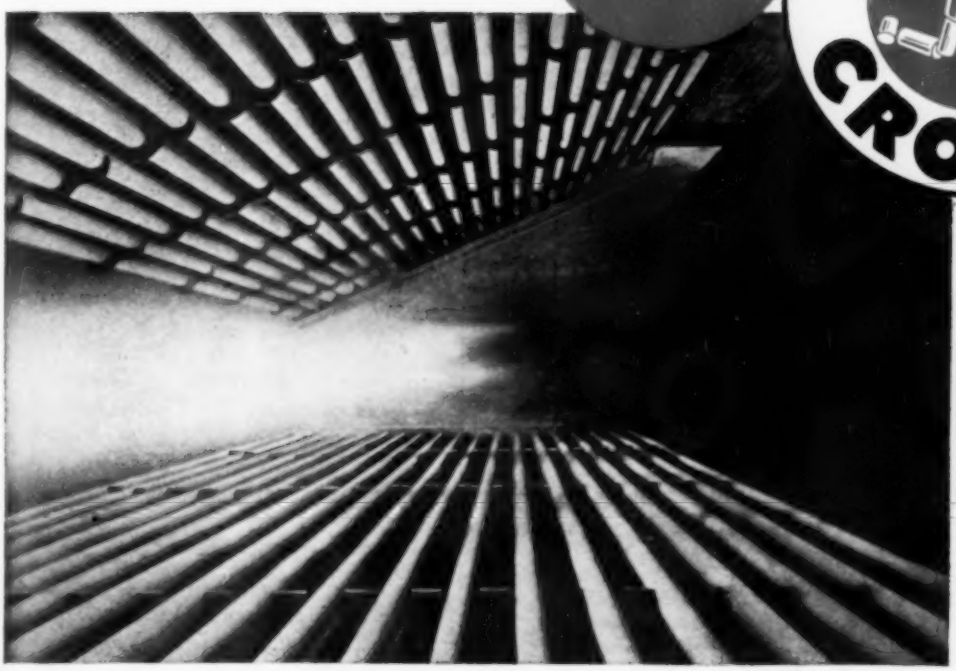
Six thousand persons employed in plastics process industries are threatened with unemployment. Three firms are producing phenol resins in Australia, all at a fraction of nominal capacities because of the caustic shortage. Beetle Elliott, with a monthly output of 120 tons of phenol powders, has had its monthly intake of the hydroxide whittled down to ten tons.

Australian Company Will Make Zinc Oxide

DURHAM CHEMICALS (Aust.) Ltd. has been incorporated in Sydney, Australia, with capital contributions from Durham Chemicals Ltd. (England) and Durham Chemicals (Canada) Ltd.

The firm intends to manufacture

WANT CORROSION RESISTANCE *at a saving?*



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the economy tubing

REMARKABLE ability to withstand corrosive attacks and oxidation from hot oils and chemicals resulting in fewer shutdowns for re-tubing — longer tube life — lower maintenance—have made B&W Croloy 7 widely known among refineries as the "economy tubing".

Developed and introduced by B&W, Croloy 7 tubing is an intermediate alloy that stands up under corrosive attack at temperatures up to 1250F much better than alloy tubing containing 5% Cr—.50% Mo, though it costs but little more. Over nine years' experience in such services fully confirms the time- and cost-saving advantages of Croloy 7.

Technical data on the properties of Croloy 7 are available for the asking. *"Call on Croloy"* any time you have a job for alloy tubing, for B&W Croloys embrace the widest choice of analyses available from a single source for refinery uses.

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zinc oxide and other industrial chemicals. It will acquire the Mascot Smelting Works in New South Wales and build plants and laboratories in Victoria. W. P. McGrath is chairman of the company.

Foreign News Briefs

Provisions for the purchase of Chilean nitrate and nonconstruction of synthetic nitrate plants in Brazil are contained in an agreement between Chile and Brazil. Chile has a similar arrangement with Argentina.

Quebracho extract exports from the Argentine in the second quarter of this year amounted to 54,434 metric tons compared with 82,402 metric tons in the second quarter of 1946.

Solvay-Werken, Rheinberg, Germany, according to U. S. Department of Commerce, will ship 5,000 metric tons of caustic soda to Norway in exchange for 2,850 tons of whale oil to be supplied to the United States and British Zone.

Hungary has a three-year program for rehabilitating its leather industry. Some of the basic raw materials, including pure tannin, are produced domestically but it will be necessary to import a good part of tanning material requirements.

Rose oil production in Bulgaria is now a government monopoly. Although many of the 24 distilling plants are nominally owned by individuals, purchase and sale of the oil is carried out by the government.

Bahia, Fortaleza, and Paraiba, Brazil, shipped 161 tons of carnauba wax to the United States in June. This represented nearly 70 percent of total carnauba exports for that month.

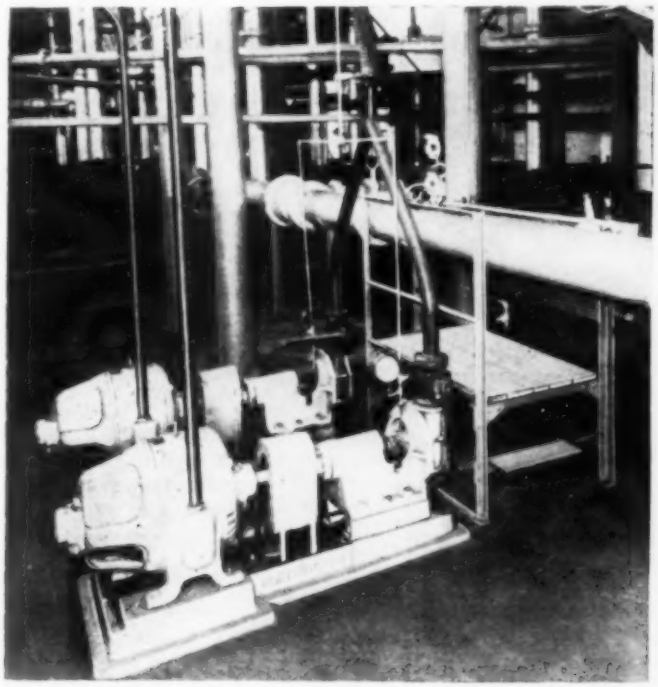
New rayon plant of 10-tons daily capacity, will be built for Dynamit Nobel, Bratislava, Czechoslovakia, by Oscar Kohon & Co. of New York. This announcement was published in the newspaper, Pravo Lidu.

Production of copper salts may be undertaken in Chile with the government promoting such a development. The proposal is meeting with favorable consideration because it would open up a new outlet for copper which is in ample supply.

Work is under way at Sydney, Australia, on a new plant for the Frederick Stearns & Co. division of Sterling Drug, Inc., of Detroit, Mich. The plant is expected to be completed by the end of this year.

THE CORROSION FORUM

Edmond C. Feller, ASSISTANT EDITOR



Sodium Chloride versus Construction Materials

Part 1 of a symposium in which typical materials of construction are evaluated for services involving sodium chloride

←Two Worthite pumps in salt refinery transferring saturated brine from evaporators to filters. Brine is hot, up to 160 deg. F., and contains 40-50 percent solid salt crystals. Although iron and steel are commonly used to handle sodium chloride, tough jobs like this may demand special materials.

IRON AND STEEL

ALBERT W. SPITZ
American Cyanamid Company
New York, N. Y.

Cast iron and carbon steel are widely used throughout industry for pumps, valves, tanks and piping, handling natural brine, sea water, and relatively pure sodium chloride solutions. Corrosion generally occurs; however, its rate can usually be kept low enough to make their use practical, if iron contamination is not objectionable. Careful design and installation of piping and equipment used for salt solutions, brines, and sea water are important. Corrosion in such systems is accelerated by contact of dissimilar metals, by dissolved air, by stray electrical currents, and by excessive velocities and turbulence.

In addition to consideration of the design features noted, chemical control is generally used to reduce corrosion in refrigerating brines. This may be accomplished in closed systems by adding an inhibitor, such as sodium dichromate, and adjusting the pH to a value between 8 and 9. For open systems disodium phosphate is recommended with a pH between 7.5 and 8.

Correct design, supplemented by the use of inhibitors and pH control, has been found to reduce corrosion in brine systems as much as 95 per cent.

WORTHITE

W. E. PRATT
Worthington Pump and Machinery Corp.
Harrison, N. J.

The corrosive effect of sodium chloride on metals and alloys is extremely variable depending on concentration, temperature, velocities and impurities or solids present in the environment. Worthite (a complex alloy containing 20 percent Cr, 24 Ni, 3 Mo, 3.25 Si, Cu, Mn, 0.07 max. C, bal. Fe) is practically perfectly resistant to all conditions except highly acid conditions at high temperatures. The presence of most acids means that hydrochloric acid is also present. Thus $H_2SO_4 + 2NaCl = 2HCl + Na_2SO_4$. Where both H_2SO_4 and HCl are present the effect on metals and alloys may be severe because insoluble corrosion products from one acid may be soluble in the other acid.

An outstanding economical application for Worthite pumps and valves is in the handling of hot salt slurries in salt refineries. The salt slurry from the evaporator pan carries about 50 percent salt crystals at an average temperature of 160 deg. F. This slurry is pumped to vacuum filters or separators and Worthite pumps have given eight years service to date without requiring any repairs. Pump stuffing boxes are sealed with water seals and packing lasts about nine months. Worthington Bulletin W-350-B8 gives details on such installations.

Cold brine solutions are handled in both all iron and standard fitted pumps with relatively good service records. However, in the salt refinery where returns from the separator carrying 3 percent crystals mix with the evaporator feed, and where the temperature is a little higher, there is some corrosion. Bronze impellers last longer than cast iron as the soft graphitized surface formed on a cast iron impeller is worn off by the high velocity brine carrying a small amount of crystals.

However, the galvanic action of bronze (impellers and rings) on the cast iron casing has been known to perforate the casing in three to four years. Worthite impellers and rings in such pumps will last indefinitely and there is no noticeable galvanic action with the cast iron casing.

The lack of galvanic action between cast iron and Worthite has led to the use of Worthite internal parts in many pumps handling sea water, harbor water and brackish river or well water. Worthite is preferable to the ordinary stainless steels as the galvanic action with cast iron is less and Worthite does not pit in sea water during shut down periods as do many of the stainless steels. Worthite impellers are used in large condenser circulating pumps handling San Diego harbor water.

Oil field brines are notoriously corrosive and large numbers of Worthite pumps are used for transfer service to collecting ponds and for pumping through pressure filters prior to injecting the salt water back into the ground. High pressure Worthite centrifugal pumps and Worthite liners in reciprocating pumps are used in the injection service. The results of a test of Worthite in oil field brine is as follows:

	Test No. 1	Test No. 2
Liquid	Salt water, pH 8.1	
Process	Oil field salt water disposal	
Temperature	60 deg. F. aver.	
Duration of Test	85 days	217 days
Aeration	Slight	
Agitation	Normal flow of water	
Corrosion Rate	Less than 0.1 mils/yr.	No loss
Source	Inco test spools	

Worthite pumps are also being used to handle the oil field brines after chlorination.

Another tough service involving the handling of sodium chloride and crystals is in electrolytic caustic soda plants. The discharge of the slurry from the salt catcher, in connection with the evaporator, involves pumping a fairly heavy and hot slurry along with some NaOH. Worthite pumps

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To date, six articles or symposiums have appeared in this series and are now available individually as reprints. Each considers the fitness of typical construction materials for service with a particular chemical. Chemicals covered and reprint prices are listed below. Address Corrosion Forum Dept., *Chemical Engineering*, 330 W. 42d St., New York, 18, N. Y.

Phosphoric Acid	25c.
Sulphur	10c.
Acetic Acid	25c.
Chlorine	25c.
Hydrogen Peroxide	15c.
Sulphur Dioxide	25c.

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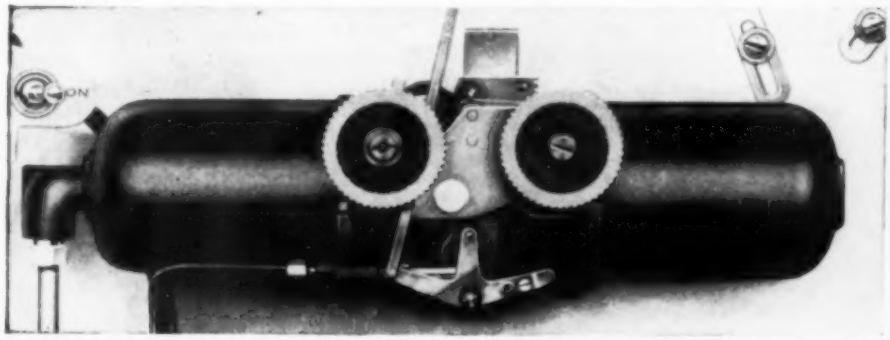

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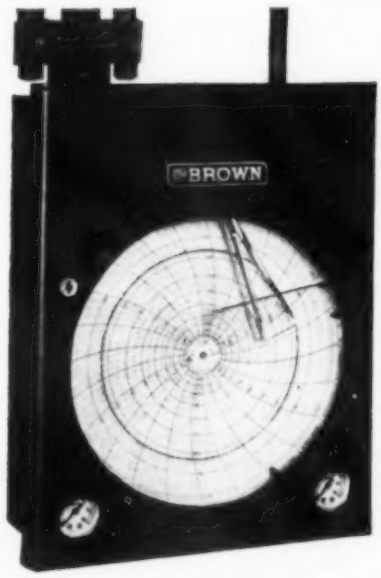
Hermetically sealed within a corrosion-resistant unit. Self-compensating for ambient temperatures. Proportional Band Dial calibrated from 1 to 150%. Automatic Reset Dial graduated in units from 1 to 10. Either dial may be set to process characteristics without affecting adjustment of the other.



DISCRIMINATING buyers for leading industries — oil, chemical, textile, metal working, glass, food, drug, ceramics and others — have demonstrated their preference for Brown *Air-o-Line* Controllers by orders and repeated re-orders. This wide acceptance proves, better than anything we can say, that Brown *Air-o-Line* Controllers deliver a unique quality of performance for positive control of even the most complex processes.

The Brown *Air-o-Line* Controller easily conforms to any process control problem. For operation, the control index is set at the desired point; then a turn of the graduated dials "tunes-in" proportional band and automatic reset — quickly, precisely, and without guesswork. Once "tuned-in," *Air-o-Line* is completely automatic, lining out control at the exact set point and correcting for all load or throughput changes without cycling or offset.

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BROWN Air-o-Line **FLOW CONTROLLERS**

***Air-o-Line*—THE COMMON DENOMINATOR OF PROCESS CONTROL**

stand up in this service with no noticeable wear. The explanation of this performance is given in Worthington Bulletin W-350-B8.

Acidified brine, as used in some types of synthetic rubber plants, is a typical acid-salt condition which can be handled in Worthite pumps and valves. The temperature of this brine is low and the acidity is rather mild but ordinary stainless steel is not useful. Troughs of Type 316 stainless steel have given trouble at welded joints, but where no welding is used in the construction good service has been reported. While Worthite castings contain 70 percent more alloy than the moly-stainless steels, Worthite pumps cost less due to standardization on the one type of alloy. It is for this reason that Worthite pumps are much more widely used in many conditions where the stainless steels would be quite satisfactory.

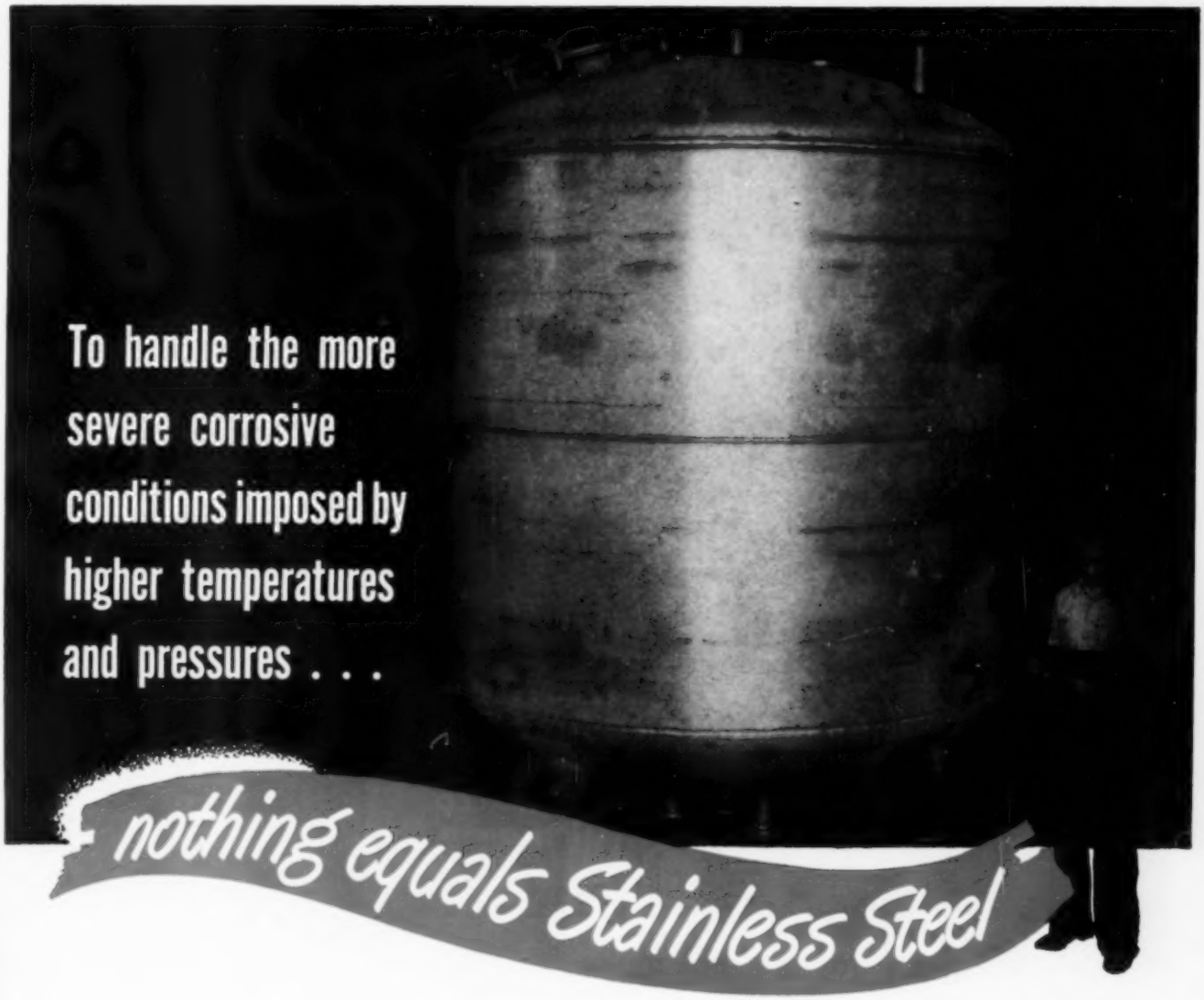
A phenomenon called crevice corrosion has been noted on stainless and other high-chrome alloys in the sea water corrosion tests conducted by Inco at Kure Beach, N. C. This corrosion occurs under non-metallic washers used to prevent galvanic corrosion with the metal support racks. Worthite has not been entirely free from this type of corrosion underneath washers, but it has been free from pitting elsewhere on the surfaces. It is interesting to note that no crevice corrosion has been experienced on any all-Worthite pumps or on Worthite internal parts in bronze or cast iron pumps handling seawater. It is, therefore, probable that the velocity inside centrifugal pumps prevents the formation of marine growth over crevices, which certainly is a contributing factor to crevice corrosion or oxygen concentration cell corrosion in such an environment.

CHEMICAL PORCELAIN

JOHN S. CHOWNING
Lapp Insulator Co., Inc.
LeRoy, N. Y.

SINCE there are more economical materials which give satisfactory service for the general handling of sodium chloride, the use of chemical porcelain is limited to special applications.

Chemical porcelain is not attacked by any corrosive chemicals, with the exception of hot alkalis and concentrated phosphoric and hydrofluoric acids. In addition, its physical structure of a dense, homogeneous, nonporous body makes it an ideal material for handling sodium chloride in the presence of other highly corrosive chemicals, such as, for example, sodium chloride in combination with other



IT is a fact that many of the new chemical processes, or improvements in old processes, developed in recent years would not be possible, or economical, without the use of corrosion-resisting Stainless Steel.

For, in his efforts to obtain better yields, greater speed and lower cost of production, the chemical engineer has found it necessary to raise processing temperatures and pressures, higher and higher.

But higher temperatures and higher pressures usually involve more severe corrosive conditions . . . conditions that ordinary materials cannot cope with. That is why today, the amount of Stainless Steel used by the chemical industry is many times greater than 10 years ago, and is steadily increasing. In Stainless Steel —and especially in U·S·S Stainless— you will find the answer to many of your most pressing problems.

Because of its record of past performance, U·S·S Stainless Steel deserves your consideration wherever the reduction or elimination of corrosion is important . . . where freedom from contamination is essential . . . where plant shutdowns or process interruptions due to corrosive failures must be avoided . . . wherever corroding equipment can cause fairly harmless compounds to become explosive.

Our engineers are specialists in the use of Stainless Steel. They know what it has done and what it will do in almost any kind of service. You will find their cooperation and advice extremely helpful not only in selecting the right Stainless Steel to exactly fit your needs, but in its efficient fabrication as well.

USS STAINLESS STEEL — UNITED STATES STEEL

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7-816

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metallic salts, and the corrosive mineral acids. When materials must be free from metallic contamination, chemical porcelain is used.

Chemical porcelain equipment is available in the form of piping, Y and angle valves, plug cocks, safety valves, and many special fabricated pieces.

SILICONES

J. A. McHARD
Dow Corning Corp.
Midland, Mich.

SILICONES in their various forms have been tested for resistance to hot and cold sodium chloride brine solutions. The method of testing is essentially that given for A.S.T.M. D 543-43 and the results are tabulated below.

Various silicone fluids were exposed for 7 days to sodium chloride brines at room temperatures and at 100°C. Changes in viscosity after such exposure are given in Table I together with an evaluation based on their viscosity behavior.

Table I—Resistance of Silicone Fluids to NaCl Brines (7 days)

Type Fluid	NaCl Conc. And Deg. C.	Viscosity Increase, %	Evaluation*
200	5%, Room	−0.5	good
	5%, 100°	2.0	good
	26%, Room	−2.5	good
	26%, 100°	0.0	good
500	5%, Room	0.0	good
	5%, 100°	1.5	good
	26%, Room	−1.5	good
	26%, 100°	0.0	good
701	5%, Room	0.0	good
	5%, 100°	2.0	good
	26%, Room	5.0	good
	26%, 100°	1.0	good

* Ratings are based on observation of the test samples as well as on measurable changes in viscosity.

The stability of these Silicone fluids in contact with sodium chloride brines is also a measure of the resistance of the silicone greases to salt solutions.

For example, in one industrial application a silicone valve lubricant, DC Valve Seal A, had 7 times the lubricating life of an organic grease in a line handling magnesium chloride brine at 80°C.

Protective coatings formulated with Silicone Resins, DC 801, DC 802, DC 803 and DC 804, have been used effectively to prevent corrosion of metal strips exposed to salt spray. The two electrical insulating varnishes, DC 993 and DC 996, show excellent insulation resistance after immersion in a 3% sodium chloride solution. Test specimens of DC 993 and DC 996 prepared according to Bureau of Ships Specification 17-1-56, had infinite insulation resistance after 5 minutes immersion in 3% sodium chloride. No significant changes in

insulation resistance were observed even after 10 days of immersion.

Samples of Silicone-glass laminations bonded with DC 2130 have been tested for resistance to 5 and 26% sodium chloride at room temperature and at 100 deg. C. The results are given in Table II. There were no measurable changes in the size or appearance of these test samples.

Table II—Resistance of Silicone Resin DC-2103 to NaCl Brines (ASTM D-543-43)

Resin	NaCl Conc. And Deg. C.	Percent Increase in Wt.: After 7 Days	Percent Increase in Wt.: After Reconditioning*	Evaluation†
DC2103	5%, Room	0-1	0-1	good
	5%, 100°	0-1	0-1	good
	26%, Room	0-1	0-1	good
	26%, 100°	0-1	0-1	good

* After reconditioning for 7 days. Samples showed no change in volume.
† Ratings are based on measurable changes and on physical appearance.

In general, Silastic shows good resistance to both hot and cold brines. Test data given in Table III show remarkably little change in properties after exposure. In summary it appears that ordinary salts solutions either hot or cold have little effect on the commercial grades of silicone varnishes, resins, fluids, greases, and Silastic.

Table III—Resistance of Silastic to NaCl Brines (ASTM D-543-43)

Silastic Stock	NaCl Conc. And Deg. C.	Wt. Increase, %	Vol. Increase, %	Shore Efficiency Retained, %*	Evaluation†
120	5%, Room	3.5	1.0	89	good
	5%, 100°	4.0	3.5	65	good
	26%, Room	−1.0	−3.0	82	good
	26%, 100°	0.0	1.0	53	fair
125	5%, Room	1.0	2.0	83	good
	5%, 100°	1.0	0.0	83	good
	26%, Room	−5.0	−2.0	106	good
	26%, 100°	3.5	0.5	83	good
150	5%, Room	6.0	1.0	78	good
	5%, 100°	2.5	2.5	48	fair
	26%, Room	−1.0	−2.0	84	good
	26%, 100°	0.5	2.5	53	fair
160	5%, Room	5.0	1.5	117	good
	5%, 100°	2.5	1.5	95	good
	26%, Room	−1.0	−2.5	97	good
	26%, 100°	−2.5	0.5	92	good
160R	5%, Room	0.0	−0.5	92	good
	5%, 100°	1.5	−0.5	79	good
	26%, Room	2.0	−1.5	88	good
	26%, 100°	1.0	0.5	78	good
167	5%, Room	−6.0	−3.0	82	good
	5%, 100°	1.0	1.5	58	fair
	26%, Room	0.0	−1.5	83	good
	26%, 100°	0.5	0.0	59	fair
180	5%, Room	4.5	−5.2	75	good
	5%, 100°	−0.5	−9.5	61	fair
	26%, Room	−7.5	−1.3	100	good
	26%, 100°	0.0	1.8	65	good
181	5%, Room	0.0	−2.0	116	good
	5%, 100°	0.5	3.5	79	good
	26%, Room	0.0	−2.5	129	good
	26%, 100°	0.0	1.5	65	good

* Percent of Shore efficiency retained = (100) (hardness × elasticity of treated sample)/(hardness × elasticity of untreated sample). †Rating is based on changes in weight and volume, changes in durometer and elastometer readings, and observation of the physical condition of the test sample, and on the effects of reconditioning test samples for 10 days.

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This Dowtherm vapor heating system solved one manufacturer's problem—and incidentally saved him great expense. He needed a system that would heat 6 process vessels, each of which was required to operate at a different temperature.

Foster Wheeler engineers designed a Dowtherm vaporizer as the single source of heat. Then, to obtain different temperatures in the vessels, throttle valves to control the amount of vapor admitted to each were specified between the vapor main and individual vessels. Controlled, even heating of the product proceeded by transfer from condensing Dowtherm vapor in coils within the vessels.

In your own processing operations, a flexible vapor heating system like this may reduce your cost of manufacture and help you produce a more uniform product. Bulletin ID-46-3 describes in full this and other process heating systems for high temperature, low pressure service.

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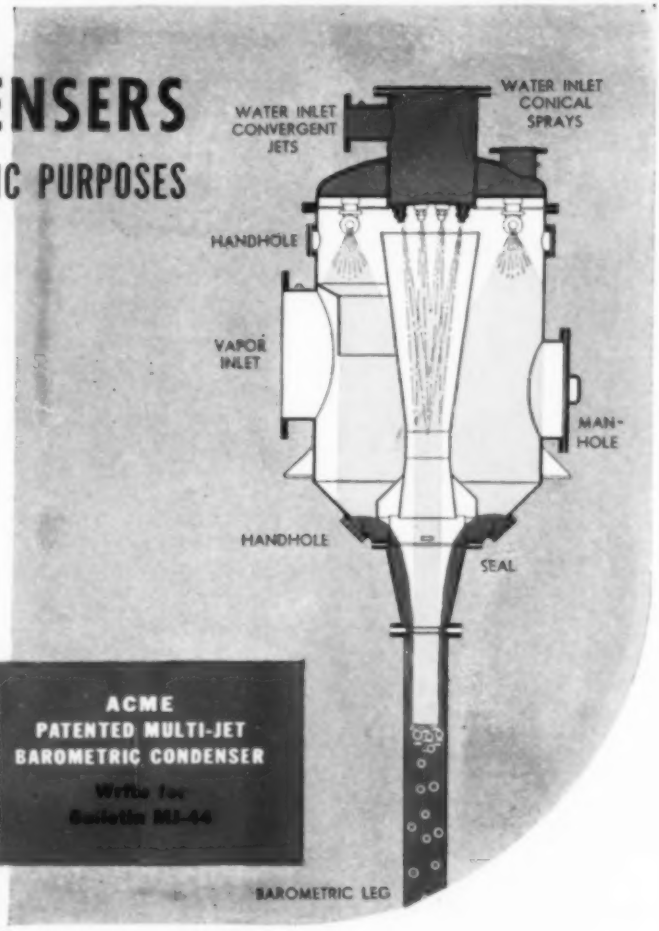
ACME BAROMETRIC CONDENSERS *Engineered* FOR SPECIFIC PURPOSES

Barometric condensers provide an economical means of condensation for most high vacuum processes. Operating by means of gravity, a barometric condenser requires no costly pump for the elimination of the condensate, merely sufficient headroom for a 34-foot tailpipe. Barometric condensers are especially adaptable where there is no need to recover the condensate—where there is a high percentage of incondensible gases—where there are unusual fluctuations in the load—where the water supply is dirty or vapors contain solids. Two that have proven most successful in actual operation are the Acme Counter-Current and the Acme Patented Multi-Jet, described below.

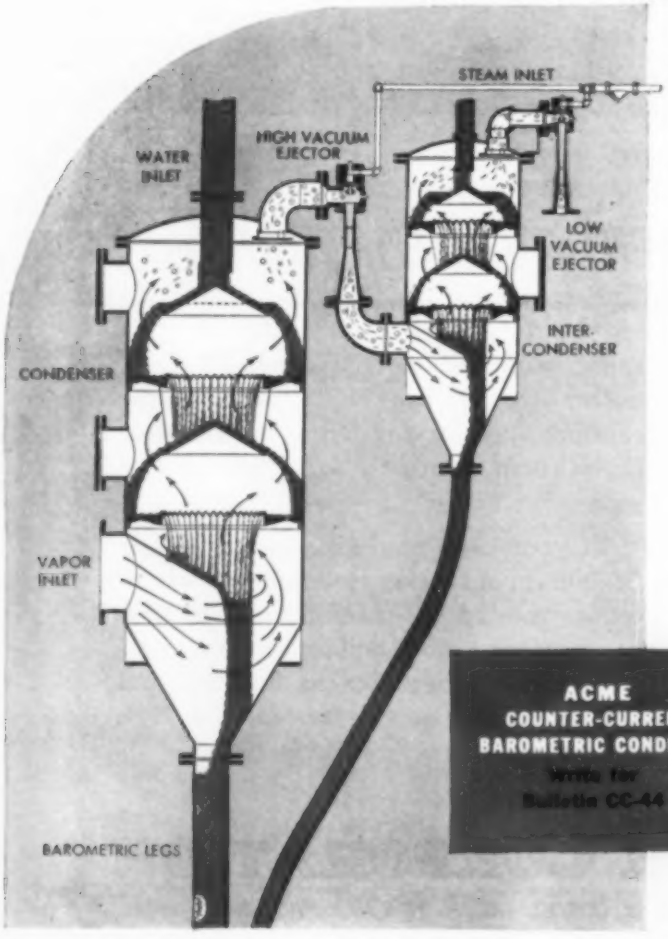


ACME PATENTED MULTI-JET BAROMETRIC CONDENSER

Write for Bulletin MJ-44

THE ACME PATENTED MULTI-JET BAROMETRIC CONDENSER

. . . The most economical condenser where vacua not exceeding 27" Hg. are to be attained. Vapors entering the condenser rise through a cold spray from a series of converging jets, adjustable for maximum condensation. This countercurrent movement assures more complete condensation. The jets, in turn, wash the incondensible gases, along with the condensate, down through the tailpipe, without the use of an ejector or intercondenser. This process is made possible only through a patented arrangement with sealed baffles that permit the use of jets, while preventing the escape of vapors, thus forced to the top of the condenser.



ACME COUNTER-CURRENT BAROMETRIC CONDENSER

Write for Bulletin CC-44

THE ACME COUNTER-CURRENT BAROMETRIC CONDENSER

Where vacua exceeding 27" Hg. are to be attained, we recommend use of the Acme Counter-Current Condenser. Besides the advantages previously noted, this unit is less expensive to construct and more compact in design than other comparable equipment. It consumes less water and is scientifically proportioned for minimum pressure drop. Construction is simple and all parts are readily accessible. Available in many combinations with ejectors and intercondensers, Acme barometric condensers are specifically designed for any desired vacua and for most efficient operation in any particular process or under any set of operating conditions.

ACME *Processing Equipment*

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FROM THE LOG OF EXPERIENCE

Dan Gulleben, ENGINEER

OLD COL. CUNNINGHAM, founder of the present "Imperial" sugar refinery at Sugarland, Texas, was proclaimed to have "ideas which like his head, his heart and himself were large and progressive." Fifty years ago he had the modern notion that improved working conditions effected improved output. When he stuck his head through the pan manhole and saw his emergency repairmen toil and sweat, his heart went out to them. Modern comfort fans were not available then and so he stationed a quartet of singing darkies above the pan to make the time seem to pass more quickly.

TWENTY SQUARE MILES of his farm were taken over by the state prison board 40 years ago, complete with 300 mules and a complement of farm equipment. The board's purpose in buying the land was to provide healthful outdoor work for their charges and to avoid the abuses of farming out prison labor. It was agreed that over a ten-year period, the prisoners would produce cane for the Colonel's mills and a basis was established for arriving at a price. Seven square miles of land were retained upon which the Colonel conducted diversified agriculture to set the pace for the prisoners. "Work or want" was not imposed upon the prisoners. Their "collective farming" was "made work." It lacked inspiration, the profit incentive, and whatever else it takes to lift man above the ordinary. The cane therefore progressively deteriorated and finally reached the condition of thin spindles of closely spaced joints, unfit for sugar production. Climatic conditions also discouraged cane culture and so it gradually petered out. Thereafter the the Colonel's sugar making activity was confined to refining imported raw, as had in fact been anticipated when he built a refinery around 1900.

THE LAND that the Colonel retained, seven square miles, is now a part of the chemurgical unit that includes a cannery, cotton plant, stock raising facilities, and the 1000-ton sugar refinery on the banks of Oyster Creek. The farm produces grain, cotton, vegetables, fruit and cattle, but no cane. The estate furthermore includes the modern and alert village of Sugarland, completely equipped with paved streets, sewers, water supply, gas and electricity, and all of the accessories required for the public weal. The business section contains a railway station, post office, merchandising center, bank, cinema and the administrative office of the estate presided over by the perennial Harry Thompson and I. H. Kempner, father and son, the principal successors to Col. E. H. Cunningham and his partner, Col. W. T. Eldridge. The residence section is attractively designed making generous use of brick. Varicolored landscaping and shade trees are provided in front and personal gardens in the rear. Every house has a garage but no public transportation system is required as the portal to portal distances are conveniently negotiated on foot. Physical, intellectual and moral health are promoted by a hospital, tax-supported school system and four churches. The school system is a modern arrangement of single story buildings for the respective grades, crowned by an imposing high school building and auditorium for public meetings. One block is set aside for religious purposes and on each of the four corners the company has built a church and to each it makes an annual grant of $1,000. The estate leases the houses only to the employees of its industries. There is no housing shortage and no unemployment. Cradle to grave services are provided and even careers. Every man is guaranteed full employment even though it may require seasonal shifting among the industries, farms and public works.

OYSTER CREEK does not reach tide water and so the raw sugar is delivered by rail on a processing in transit basis from the port of Galveston, 50 miles away. There is a short section of canal now storing irrigation water for which the Colonel may have had some ambitious plans. He built a twenty mile belt railroad from his refinery to cut across the transcontinental systems of the Southern Pacific, Missouri Pacific and the Santa Fe, and required all freight between the junctions and Sugarland to be handled by this road in order thereby to share in the freight receipts. Eventually he sold the road and equipment for $2,000,000.

THE REFINERY GREW upon the nucleus of the old cane mill. In the process of growth a sugar refinery does not expand its units in size and efficiency. Rather it expands by adding more units. It starts with four legs, as it were, and eventually stretches out into a centipede. Then, to continue the comparison, the engineers replace the centipede with an elephant as they did at Crockett and Brooklyn. The improvement lies in the fact that for operating purposes a leg is a unit whether large or small. Now the Imperial refinery staff has developed a plan of reconstruction and has thus far provided a modern two-unit, 400-lb. steam plant to replace the multiple unit low pressure plant. Furthermore, noncondensing turbines furnish power and process steam for the refinery and associated industries, and when the refinery is idle some condensing equipment substitutes for the noncondensing. A model char house was built in 1925, designed by Robert Kent and Louis Schiller and equipped by Joubert and Goslin. Lofty ceilings provide good ventilation. The equipment, starting with tanks at the top and following respectively below with filters, dryers, kilns, coolers and conveyors, is arranged crosswise of the buildings in three separate sets so as to have one set for each quality of liquor. The top story is elevated sufficiently to provide the necessary gravity head for the filters. Below the filters there is one high story for storage hoppers, followed by a story for distributing conveyors. Six men per shift operate this house including the kilns which are fired by natural gas.

NO ATTENDANCE is required on the liquor tank floor. The tanks are provided with individual overflow pipes that terminate in a bucket on the filter floor and this in turn overflows to sweet water. When an over-

flow occurs, the bucket actuates a siren to attract the filter operator and, when he observes which tank is overflowing, he telephones to the station that is pumping the liquor. When operation of the siren was instituted, Col. Eldridge, the surviving partner of Col. Cunningham, still lived in the plantation house adjoining the char house. After a night's disturbance by the occasional blasts of the siren, he demanded of Supt. Ben Varnau, "Son, what is that siren that I heard all night?" Ben's description drew admiration for the device and he added, "That had me worried. I thought the plant was burning down." During an idle weekend the siren blasted a signal without apparent cause. The attendant was flabbergasted. When he went away the disturbance was repeated. The philosophers could not explain the phenomenon. Finally the mystery was solved. A field rat had strayed into the building, probably following the trail of a lunch basket. To satisfy his craving to lick the bottom of the bucket he hopped in only to be frightened away by the siren.

BEN (B. H.) VARNAU came to Sugarland in the days when able bodied men worked out their poll tax on the public roads! The sugar house operators were mostly cowboys adorned with spurs, shooting irons and hip flasks. They possessed no mechanical instincts. The lack of performance of an old direct acting pump concerned the cowboy not in the least, provided only the piston was moving. According to his definition of his duties, "I'm supposed to keep 'er movin'; if she don't pump, it ain't no fault o'mine."

One of the sons of John A. Wogan (publisher of the famous house organ, "Wogan's Wise Words") operated a "smear house" wherein he elaborated high grade molasses into raw sugar. As the margin shrank on account of increased tariff and because the Cuban mills improved their extraction so that the molasses which they sold to the smear houses contained a lesser amount of extractable sugar, the traffic folded up. To postpone the inevitable, Wogan essayed improvement of profits by making direct consumption sugar. For this effort he needed a man who had not had enough experience to know that it was impossible. Ben possessed the qualifications and he was available. He had no formula for producing white sugar without char so he applied horse sense and tried a defecation with lime and phosphoric acid. He achieved passable results. However, because of insecurely supported coils in his pan he

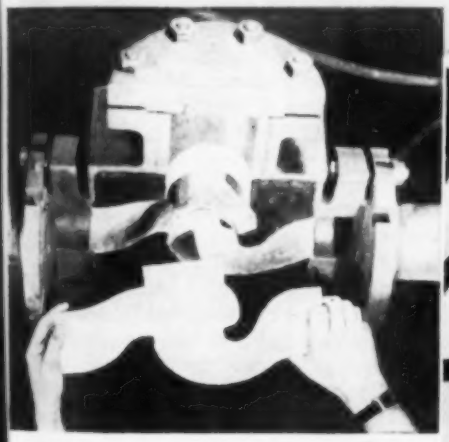
PROVED! More Flow, Less Pressure Loss *with* NEW Edward STEEL VALVE DESIGNS

To be *sure* that Edward engineers were on the right track in their efforts to cut pressure loss and wear-producing turbulence and to increase flow in new steel valve designs, the Edward laboratories set up an entire new set of research procedures and developed a whole range of new test equipment, much of it not duplicated anywhere.

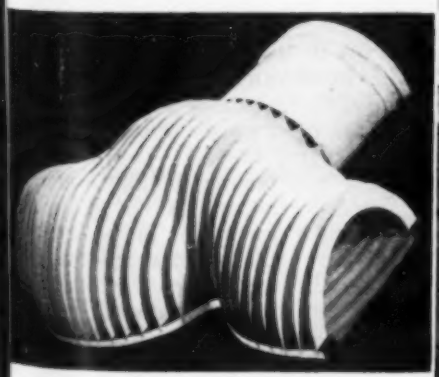
So there's no guessing in the statement that you get up to 30 per cent more flow through new Edward steel valve designs. There's proof aplenty—the evidence of actual field operation and cross-checked laboratory tests . . . the cold facts of pure mathematics, and even the convincing testimony of visual pre-testing.

Here you see plaster casts shaped by half-section plastic valve models. Each model, molded in a steel box and frozen hard, has been flow-tested to develop ideal flow contours. To compute flow test results Edward technicians even developed completely new slide rules, like the one shown. The plaster casts serve as masters from which sectional models and then the actual patterns for Edward valve castings are developed.

No valve series has ever been designed with more extensive flow research . . on no other valves is there more proven flow data.



Half section super-streamlined Edward globe valve of plastic is used in flow tests. After ideal contours for high volume and minimum turbulence are established, casts are made of flow passages.



From actual plaster casts, checked against mass of flow data, model cross section templates are built. These guide design of patterns for Edward steel valve body castings.

Edward Valves, Inc.

SUBSIDIARY OF ROCKWELL MANUFACTURING CO.

EAST CHICAGO, INDIANA

had to boil to a low density and thereby attained a low yield. Wogan visioned great profits. He decided to operate a second shift and discovered a silk hatted expert of recent European emigration whose learned discourse on the superior yield of dense massecuite impressed him. Ben, deferring to age and erudition, accepted the night shift. By way of helpfulness he came in early in the morning to assist in preparing the pan charge, at the same time issuing a warning against dense massecuite until the pan coils could be securely anchored. After a day's sleep he returned early in the evening and found the pan jumping. The learned gentleman assured him that there was nothing to worry about. When the foot valve was opened, the massecuite spluttered out mixed with random sections of copper coils like noodles. Ben assisted in the repairs and then returned to Henderson's to avoid the stigma of a failure.

BILL (W. H.) LOUVIERE (L.S.U. '15), operating superintendent of the Imperial sugar refinery, spent his college vacations at his neighborhood sugar mills in Louisiana. When he had acquired a smattering of chemistry he sought to impress old "Uncle Ed," owner of one of the crude mills, by declaring that all cane was not equal in quality. One planter's cane may contain more sugar than another's. Uncle Ed registered doubt. Cane was cane. He bought it by the ton and paid everybody alike. Nevertheless Bill induced him to segregate deliveries so as to process each planter's crop separately. Then Bill borrowed a Brix spindle and showed Uncle Ed that it sank more deeply in one planter's juice than in another's. Uncle Ed became convinced that the kid had something. He bantered a planter who had delivered low-test cane and declared "See here, your cane is mostly water. There's more Brix in Brown's cane than yours." This started an argument. The planter demanded to know "who says I put bricks in my cane." When the authority was pointed out he blurted, "You'd better send Willie back to school." Sugar boilers in the hinterland were still remunerated according to the sugar extraction per ton of cane. Litmus papers were thought to be essays written by Mr. Litmus. Even as late as 1910 a want ad in a Louisiana country paper asked for "a man to clerk in the store and read the polariscope." Subsequently monkey-wrench chemists were installed in the sugar houses who directed chemical control during the operating season and repaired pumps when the plant was idle.

NAMES IN THE NEWS

T. F. Montgomery

R. N. Lulek

R. L. Hutchison

T. F. Montgomery has been named head of the engineering section of the plastics and chemicals division of The Glenn L. Martin Co. Mr. Montgomery will work at the Painesville, Ohio, plant which manufactures vinyl chloride type resins.

Whitney Weinrich, formerly a member of the staff of Towne Scientific School, University of Pennsylvania, has joined the staff of Houdry Laboratories as head of pilot plant development.

Charles F. Winans, chemical director of the Pennsylvania Coal Products Department of Koppers Co. since last January, has been named to the position of plant manager.

Marshall Stubbs has been appointed deputy chief and **C. W. White** appointed executive officer of the research and engineering division at the Army Chemical Center, Maryland. Col. Stubbs, a West Point graduate, holds a master's degree in chemical engineering practice from the Massachusetts Institute of Technology. Major White holds a master's degree in chemical engineering from Ohio State.

W. C. **Heidenreich**, formerly at South Charleston, W. Va., has been appointed manager of the plants of Canadian Resins and Chemicals Ltd. at Shawinigan Falls, Que. He succeeds **G. L. Pitzer** who is taking charge of a new vinylite resin plant at Texas City, Tex.

R. N. Lulek has been named manager of the ammonia division of the Heyden Chemical Corp. Dr. Lulek has been research manager of Heyden since 1946 and last summer was in charge of the organization and rehabilitation of the $60,000,000 Morgantown Ordnance Works in Morgantown, W. Va., for the production ammonia for the fertilizer program.

L. Squires has been appointed assistant production manager of the Du Pont company's ammonia department. Formerly manager of the technical section of the Belle, W. Va., Works, Mr. Squires will be transferred to the Wilmington offices where he will be in charge of technical development work in the production division. **James B. Tinker**, who has been assistant manager of the technical section at the Belle Works, succeeds Mr. Squires there.

L. H. Priday, plant manager at Parlin, N. J., has been transferred to Wilmington as assistant director of production, in the finishes division of E. I. du Pont de Nemours & Co. He succeeds **M. A. Dibble** who recently became assistant manager of the finishes division. **H. L. Priddy**, assistant plant manager at Parlin, was promoted to plant manager there.

J. C. Raaen has recently been appointed general manager of Universal Oil Products Co. laboratories at Riverside, Ill. Col. Raaen comes to Universal after spending more than 29 years in the Armed Forces.

R. L. Hutchison has been made general superintendent for Pittsburgh Plate Glass Co.'s Columbia Chemical Division and for the Southern Alkali Corp. **W. S. Straub**, succeeding Mr. Hutchinson, is superintendent and **L. J. Rimlinger** and **E. J. Corell** are assistant superintendents at Pittsburgh's Barberton, Ohio, plant.

G. F. D'Alelio has become an assistant director of research for Koppers Co., Inc.

Roy P. Whitney, formerly of the University of Maine joined the staff of The Institute of Paper Chemistry last month. At the Institute Dr. Whitney has the rank of research associate and will engage in teaching and research work.

Robert Van Tuyle is now director of research for Emery Industries, Inc., Cincinnati. He was released from the Army in 1946 with the rank of lieutenant-colonel. He returned to Emery Industries at that time taking charge of the plastics section of the research department.

Floyd J. Metzger has resigned his position as vice president in charge of liquefaction research for Air Reduction Co. to engage in private practice as consultant with offices at 60 East 42nd St., New York.

E. F. Hitch, special assistant to the management of the Du Pont company's Chambers works, Deepwater Point, N. J., has retired after 29 years

with the company. He is joining the faculty at Purdue University as professor in the department of chemistry.

M. P. O'Brien, former dean of engineering of the University of California, has joined the engineering staff of Air Reduction Co., Mr. O'Brien will be in charge of general and process engineering and has assumed the direction of liquefaction research.

J. J. Gottsegen has been appointed head of the chemical section of the Census Bureau. He was formerly with the industrial prices division of the Bureau of Labor Statistics.

E. R. Hanson has joined the staff of Foster D. Snell, Inc., New York, to head research and development in the field of plastics and rubber.

Dexter North, formerly in the Office of Alien Property, U. S. Department of Justice, has recently joined the Central Intelligence Agency of the new Department of National Defense.

F. B. Hillhouse, formerly in synthetic organic chemicals section, chemical division, Department of Commerce, is now associated with Southern Dyestuff Corp.

Sheppard T. Powell has been named by Maryland's Governor Lane as a member of the Water Pollution Control Commission of Maryland which was created by legislative enactment at the last session of the State Legislature.

Clarence K. Morehouse, dry cell battery specialist, formerly with the National Bureau of Standards, has been engaged to do research work on battery problems for the Winchester Repeating Arms Co. and Bond Electric Corp. Divisions of Olin Industries.

William R. Wilcox has joined E. I. du Pont de Nemours & Co. as chemical supervisor of phenothiazine production at the Houston, Tex., plant.

C. S. Grove, Jr., has resigned as professor of chemical engineering at Iowa State. He now holds the same title at Syracuse University where he is associated with Dr. R. E. Montonna in the University's newly organized Institute of Industrial Research.

Harry DeWalt has joined the Bjorksten Research Laboratories of Chicago as research chemist.

Samuel Spring, formerly a research specialist for the federal government has been appointed to the research and development staff of the Pennsyl-

200,000-gal. tank in two 100,000-gal. sections, with 200,000-gal. standpipe at base, for fire protection at large assembly plant.

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WATER STORAGE NEED—

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Your requirements for standard or special Elevated Steel Tanks can be satisfied in every particular by Pittsburgh-Des Moines! Let our Engineering Department work with you in determining the design best suited to your needs in type, capacity, and performance—for the storage of water or other liquids—for fire protection—or for treatment, mixing or settling tanks in any manufacturing process. Write, phone or wire for a prompt consultation.

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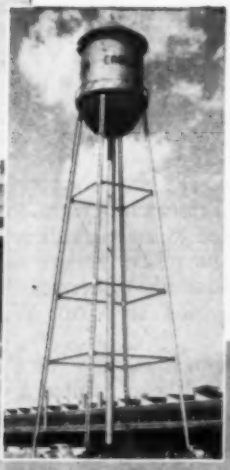
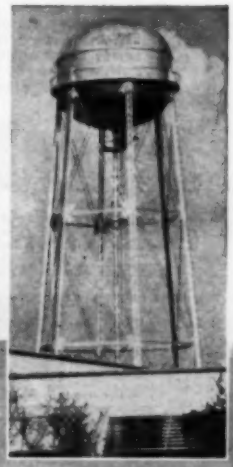
Dallas, 1216 Praetorian Building · San Francisco, 606 Rialto Building
Seattle, 507 First Avenue, South

300,000-gal. Double Ellipsoidal Tank on 125 ft. tower. Columbia Steel Co.



Hemispherical bottom 100,000-gal. tank on 116 ft. tower. Crosley Radio Corporation.

Hemi-ellipsoidal bottom 100,000-gal. tank on 44 ft. tower. El Paso Natural Gas Co.



Double ellipsoidal 150,000-gal. tank on 100 ft. tower. Walt Disney Studios.

vania Salt Manufacturing Co. He will have charge of the inorganic research group at Pennsalt's Whitemarsh Research Laboratories.

H. D. Allen and **C. M. Marberg** have been appointed research associates on the staff of Standard Oil Co., (Ind.). They will be located at Standard's new research laboratory at Whiting and will assist in connection with the company's long-range program of research in the field of chemicals from petroleum.

J. Vander Valk has been appointed technical director of the red lead division of the Lead Industries Association, New York. He was formerly connected with the research department of the Heyden Chemical Corp.

A. J. Anderson has been appointed manager of the American Potash & Chemical Corp. plant at Trona, Calif. Mr. Anderson succeeds **W. J. Metzger** who resigned.

R. G. Atkinson, formerly with Hydrocarbon Research, Inc., has accepted a position as a chemical engineer in the chemical engineering department of Phillips Petroleum Co., Bartlesville, Okla.

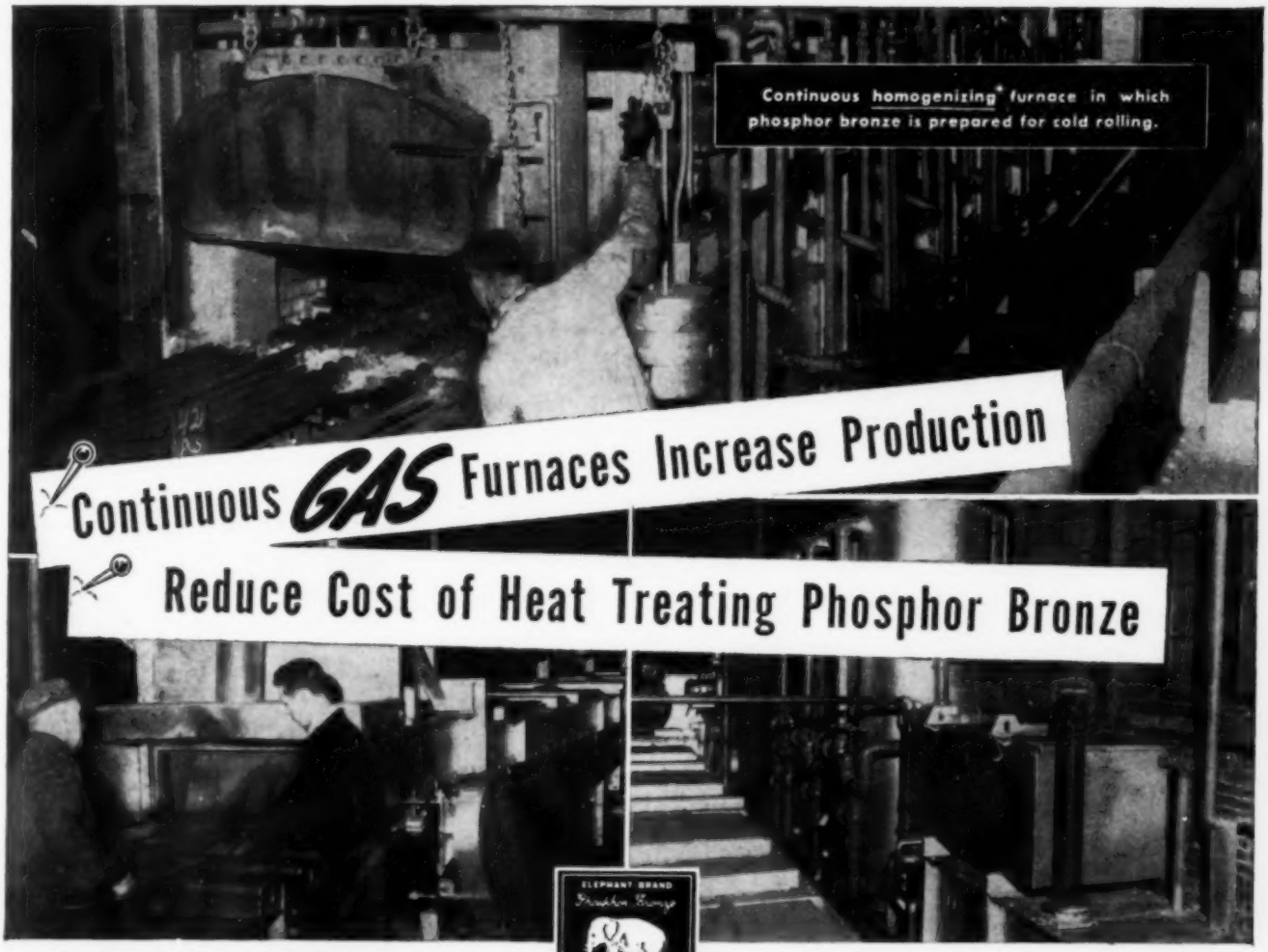
W. B. Van Arsdel, formerly principal chemical engineer in charge of the division of engineering and development at the Western Regional Research Laboratory, has been named assistant director of that unit of the Bureau of Agricultural and Industrial Chemistry at Albany, Calif.

O. F. Roller, Jr., formerly with Publicker Industries has become associated with the Atlas Powder Co., Wilmington, Del. As a member of the development department he will specialize on chemical market research and market development.

William H. Roberts, Jr., formerly manager of penicillin and streptomycin production for E. R. Squibb & Sons, has been named general plant manager of the Natrium, W. Va., plant of Glyco Products Co. which was leased from the government last winter.

W. P. Metzner, a research group leader at the central research department has been promoted to associate director of research in the rubber service department of Monsanto Chemical Co.'s chemicals division at Nitro, W. Va.

W. K. Wilson, a member of the research staff, had been granted a year's leave of absence by the Shawinigan Resins Corp., Springfield, Mass. This



Continuous homogenizing* furnace in which phosphor bronze is prepared for cold rolling.

Continuous GAS Furnaces Increase Production

Reduce Cost of Heat Treating Phosphor Bronze

Roller hearth radiant tube heated furnace using prepared atmosphere for bright annealing.

Atmosphere generating equipment used with bright annealing furnace.

Customers of Phosphor Bronze Smelting Company, 2200 Washington Ave., Philadelphia, started the whole thing—they demanded more Elephant Brand Phosphor Bronze products than the company could produce by former methods of heat treating.

So company production engineers, already familiar with GAS and Gas Equipment, specified the modern method of heat treating—with continuous, automatically-controlled, Gas Furnaces, with integral prepared atmospheres.

Here are the processes . . .

Process—*Homogenizing—a method of heat treating to develop uniform grain structure in phosphor bronze billets prior to rolling, while relieving casting strains.
Temperature—1200° F.
Cycle—6 hours
Furnace Capacity—2000 lbs. per hour

Process—Annealing of bars and sheets in a prepared-atmosphere furnace to retain brightness while relieving stresses set up during rolling or drawing operations.
Temperature—1200° F.
Cycle—40 minutes to 3 hours, varying with stock size
Furnace Capacity—5000 lbs. per hour

Here are the results . . . .

1. Pickling process eliminated
2. Production increased 80%
3. Uniformity of heat treatment assured by automatic control
4. Annealing and homogenizing costs reduced over 50%
5. Working conditions improved

Processes and results like these are worth investigating regardless of the heat treating problem in your production line; your local Gas Company Representative can be of real assistance.

METAL SHOW CHICAGO Oct. 18-24 — INDUSTRIAL GAS EXHIBIT

AMERICAN GAS ASSOCIATION
420 LEXINGTON AVENUE, NEW YORK 17, N. Y.

MORE AND MORE... THE TREND IS TO GAS FOR ALL INDUSTRIAL HEATING

is the first award granted by the company under a policy initiated to enable outstanding members of its technical staff to continue academic work and to take up studies of special interest.

G. M. Butler, Jr., has been appointed a senior engineer of the research division of the Carborundum Co., Niagara Falls, New York.

R. V. Safford is now in charge of the coal gasification pilot plant of Pittsburgh Consolidation Coal Co. at Library, Pa., and **T. G. Reynolds** has been appointed chemical engineer on coal gasification.

J. M. Martin, manager of the Pittsburgh office, has been appointed assistant general manager of the cellulose products department, Hercules Powder Co.

J. E. Wicklatz and **L. D. Goodhue** have recently become associated with Phillips Petroleum Co., Bartlesville, Okla. in the research department.

H. H. Willis has been appointed director of research and development of The Kellex Corp., atomic energy subsidiary of The M. W. Kellogg Co.

C. A. Stiegman has been appointed director of technical service by the Oldbury Electro Chemical Co., Niagara Falls, N. Y.

O. W. Herrmann, formerly head of the Fats and Oils Branch of Production and Marketing Administration, has been named assistant research administrator of the U. S. Department of Agriculture.

B. S. Old has been appointed consultant to the Atomic Energy Commission, division of research, in the capacity of chief metallurgist. Dr. Old will continue his present work with Arthur D. Little, Inc., Cambridge, Mass., and will serve the commission on a part-time leave of absence from the Little laboratory.

Louis Koenig has been named chairman of chemistry and chemical engineering research at Armour Research Foundation of Illinois Institute of Technology, Chicago.

C. R. Wagner, well-known scientist in the field of petroleum technology, is now vice president of General Aniline & Film Corp., New York, in charge of research and development.

G. W. Irving, Jr., has been named assistant chief of the Bureau of Agricultural and Industrial Chemistry. He

Something New

in Pneumatic Transmission!

The last word in . . .

SIMPLICITY

STABILITY

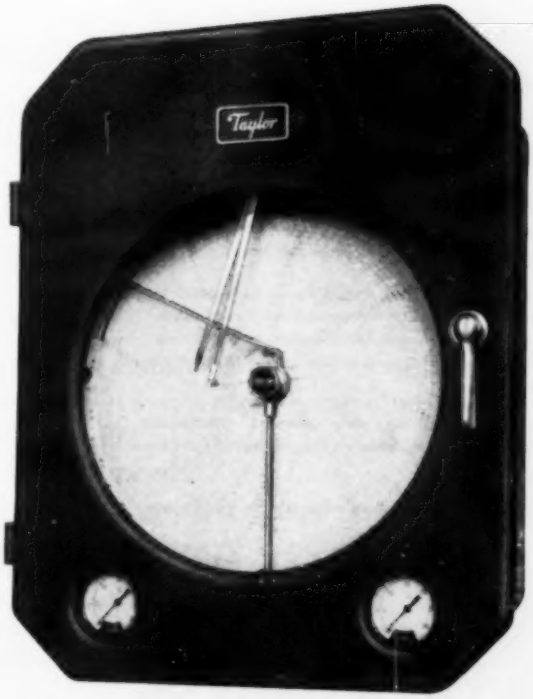
EASY ADJUSTMENT

IT'S the new Taylor 226R Pneumatic Transmitter! Helps keep every process in your plant right under your fingertips. It's accurate within 1/2 of 1% scale range, and it works as simply as this: each transmitter connects by a pneumatic lead line to a recording receiver or Fulscope Recording Controller (left) on the central control panel. You don't have to walk a step farther than that to check chart records or indications. And you have constant remote control of temperature, pressure, rate of flow and liquid level.

Available with all forms of actuation for single or double duty, indicating or recording, or as single duty transmitter-controllers with any of 5 standard types of Fulscope Control.

226R's are adjusted by the simple expedient of two micrometer screws—one for range and the other for zero setting. And they hold their calibration faithfully between adjustments. Years of tough, dependable service are built into each instrument.

Ask your Taylor Field Engineer! Ask him about "Transet" too. It's our new transmission system that eliminates time lag and cuts panel space to 1/3. Write for Bulletin 98156. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Ontario. *Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.*



TAYLOR INSTRUMENTS MEAN ACCURACY FIRST

assumed his new administrative duties during September at the Washington headquarters.

R. S. Wobus, manager of Monsanto's Norfolk, Va., plant and **William M. Russell**, branch manager, organic chemicals division, Detroit territory, have been awarded leaves of absence to attend the Advanced Management Program of the Harvard University Graduate School of Business Administration.

G. L. Ericson, chemist, has been appointed to the staff of Battelle Memorial Institute, Columbus, where he will be engaged in research on industrial corrosion problems.

L. G. Alexander has been appointed as research assistant professor in chemical engineering in the engineering experiment station at the University of Illinois, and **W. M. Campbell** has been appointed as part-time instructor in chemical engineering.

D. N. Kohn and **William Pechenick** have formed the engineering firm Kohn & Pechenick in Philadelphia following their resignation from Publicker Industries, Inc.

Richard D. Watson has been transferred by The Texas Co. from research work in Port Arthur, Tex., to the technical and research division offices in New York.

OBITUARIES

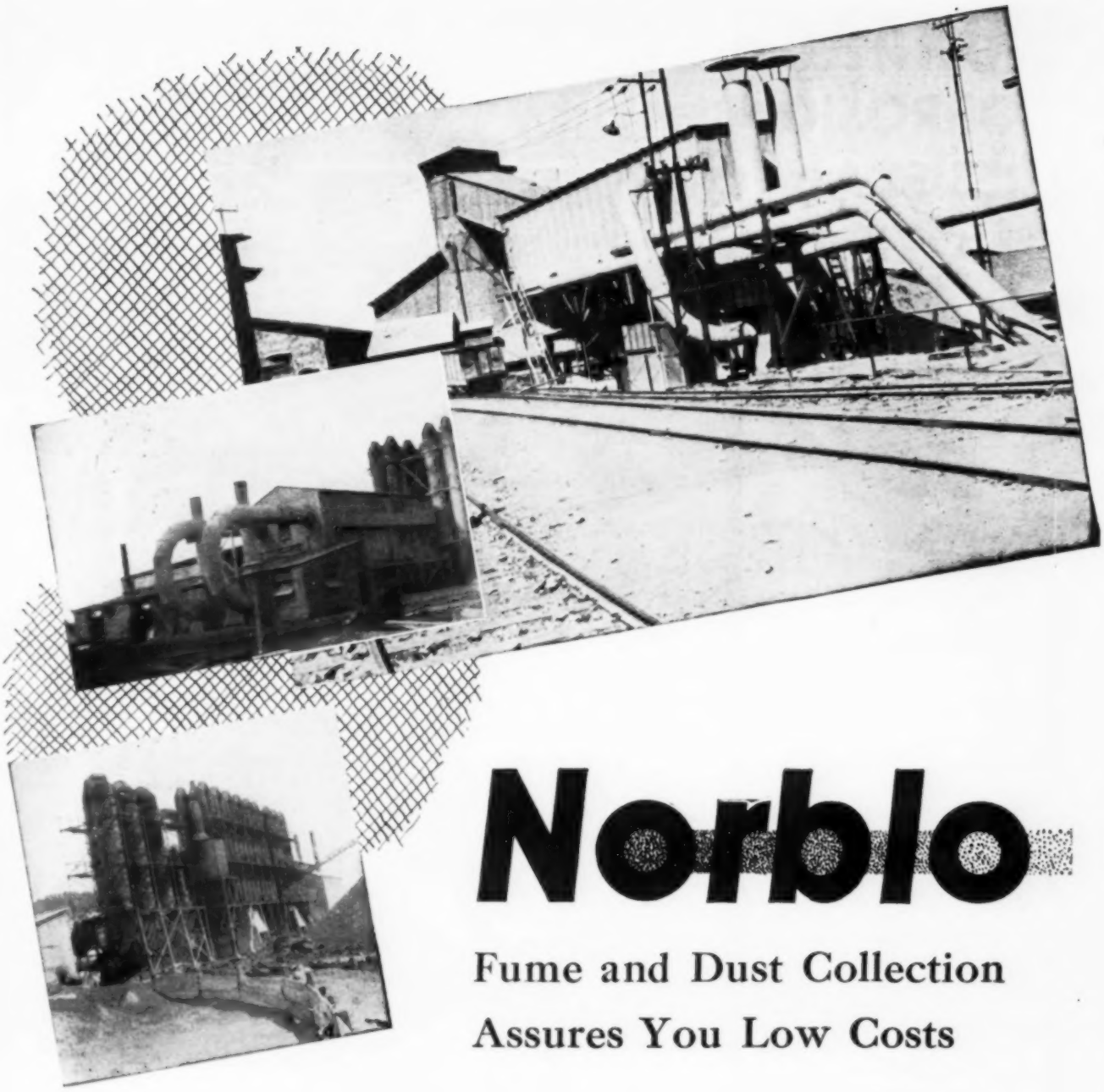
Joseph E. Sirrine, 74, founder and senior partner of J. E. Sirrine & Co., Engineers, died August 8.

Earle W. McMullen, 60, director of research for The Eagle Picher Co., died in Pittsburg, Kan., August 26.

William Elgin Wickenden, 64, retired president of Case Institute of Technology, died in a Peterboro, N. H., hospital near his summer home at Jaffrey, N. H., September 1.

Peter E. Fluor, 52, president of the Fluor Corp., Los Angeles, chemical and construction engineers for the oil industry died at Anaheim, Calif., September 10.

Walter Moll, 32, chemical engineer in the engineering division of Merck & Co., and **Henry Ober**, 31, assistant pilot plant manager, were killed in an industrial accident at Merck's Rahway, N. J., plant. They were 1937 graduates of Clarkson and Tufts, respectively, and both had been with the company since 1941. The accident occurred September 4.



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LOW COST, continuous or heavy duty fume or dust collection for all smelting, metallurgical, mining, rock products and chemical industries is provided by Norblo Automatic Bag Type equipment. The cyclic bag cleaning principle maintains uniform high efficiency and capacity of filtering for every square foot of cloth. This in turn saves power.

For your investment in Norblo fume and dust collection equipment you get assured low cost of operation and maintenance, plus improved, up-to-the-minute design and experienced competent engineering. All Norblo equipment is completely fabricated in Norblo shops. Write for bulletins — or describe your processes and let us make suggestions.

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INDUSTRIAL NOTES

Herstein Laboratories, Inc., New York, have moved into larger quarters at 128 Water Street from their former offices at 23 West 42nd Street. They specialize in industrial research and preparation of rare chemicals.

Hukill Chemical Corp., Cleveland, Ohio, is a company formed in August with offices at 4614 Prospect Avenue. Emory G. Hukill, Jr., is president and general manager; Nelson Sharpe is vice president and secretary, and Walter H. Lamprecht, Jr., is vice president and treasurer. The firm will handle specialized industrial chemicals and resins.

Black, Sivalls & Bryson, Inc., Kansas City, Mo., has set up a department of market research and analysis under the direction of Robert E. Bingham.

Handy & Harman, Bridgeport, Conn., has joined forces with Thomas J. Dee & Co., Chicago. The latter company will be known as the Dee Division of Handy & Harman and will continue to function under the present personnel. Handy & Harman's Chicago office will move to the Dee Division plant at 1900 West Kinsie Street.

Westvaco Chlorine Products Corp., New York, has appointed Walter J. Riley divisional sales manager in charge of the technical sales division.

Enjay Co., Inc., New York has named W. V. Rathbone manager of alcohol and chemical sales.

Henry L. Crowley & Co., Inc., West Orange, N. J., has appointed the Harrison Reynolds Co., 419 Commonwealth Ave., Boston, sales representative for the New England territory.

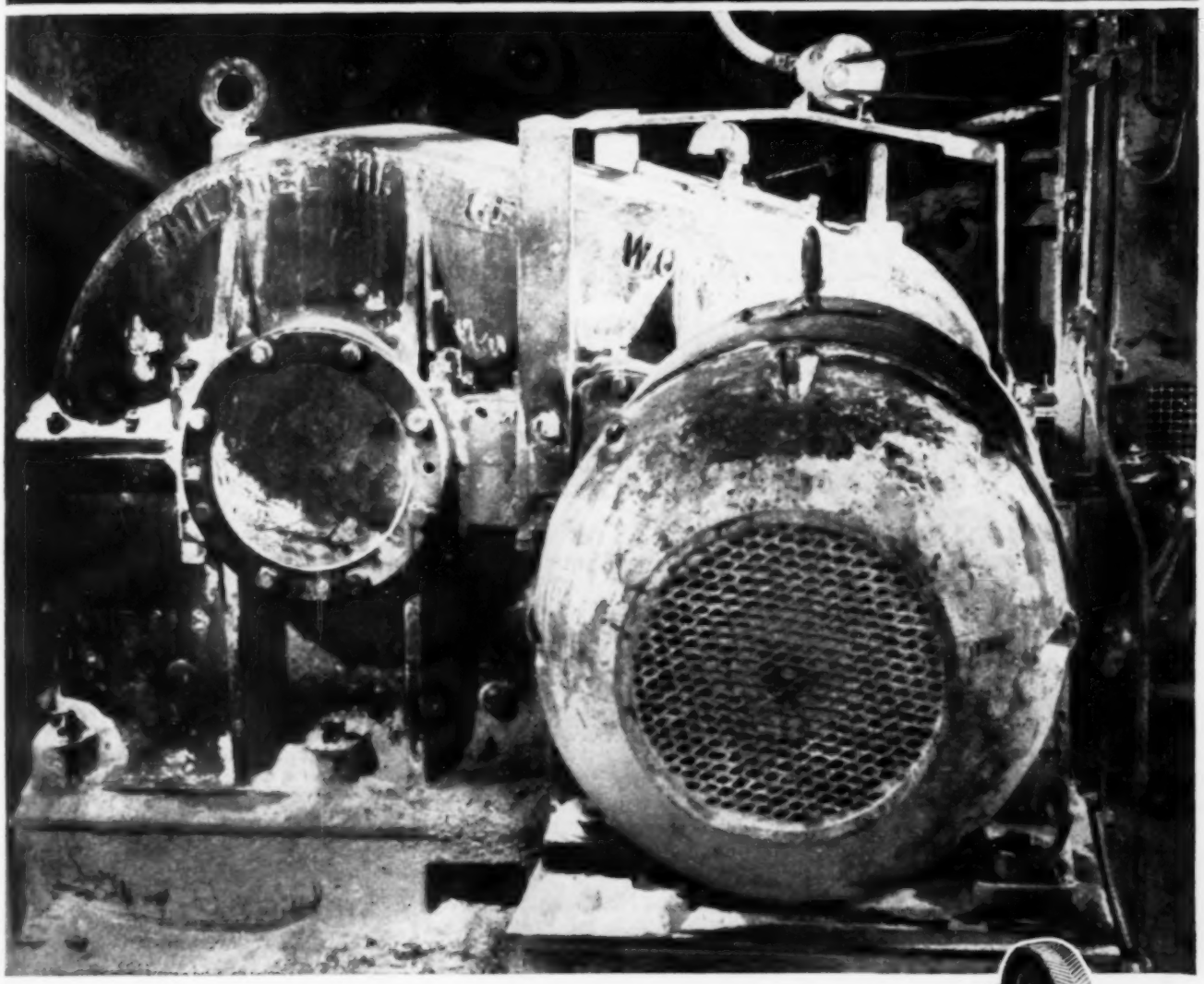
E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., has announced the award of a contract for construction of additional facilities at its East Chicago, Indiana, plant to F. H. McGraw & Co. of Hartford, Conn.

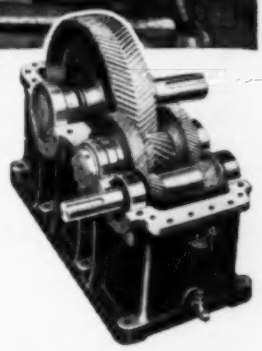
Turner Clay Products Co., Chattanooga, Tenn., is the name of a new firm headed by Dan O. Turner.

American Brake Shoe Co., New York, has appointed Selby F. Greer general sales manager for the Kellogg division.

International Nickel Co., Inc., New York, has moved the Texas technical

THIS PHILADELPHIA HERRINGBONE REDUCER *really takes a "TERRIFIC BEATING"...*





The unit shown above is a Philadelphia Double Reduction Herringbone Speed Reducer, driving a 36" drag conveyor on a lime kiln discharge . . . reduction ratio 53 to 1. It operates almost continously under severe conditions of heavy loads, dust, abrasion and dirt, . . . yet is always on the job, and has been for many years.

Philadelphia Herringbone Units are used by thousands, and are available in Single, Double and Triple types. Send for Catalog No. H-39, and please use your Business Letterhead when requesting same.

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Industrial Gears and Speed Reducers
LimiTorque Valve Controls

section of the development and research division to Room 1107, Commerce Bldg., Houston.

Carbide and Carbon Chemicals Corp., New York, has appointed Norman C. Babcock, manager of the industrial chemical division, a vice president and director of Carbide and Carbon Chemicals Limited of Canada.

American Car and Foundry Co., New York, has named Henry V. Bootes district sales manager of the New York district.

Raybestos-Manhattan Inc., Passaic, N. J., has announced the following appointments: Harry C. Dishman, equipment sales manager in Detroit; George T. Young, branch manager of the Detroit office; E. E. Juergens, branch manager of the Cleveland office; and John E. Cole, Chicago branch manager.

Philco Corp., Philadelphia, has acquired Rex Mfg. Co., Inc., Connersville, Indiana.

Angell Mfg. Co., Dayton, Ohio, has purchased the Products Identification division of the Stanley Mfg. Co. of Dayton.

St. Regis Sales Corp., Chicago, has opened a sales office in Minneapolis. Harry A. Hughes is in charge.

Libbey-Owens-Ford Glass Co., Toledo, Ohio, has named Harold M. Alexander assistant to the executive vice president.

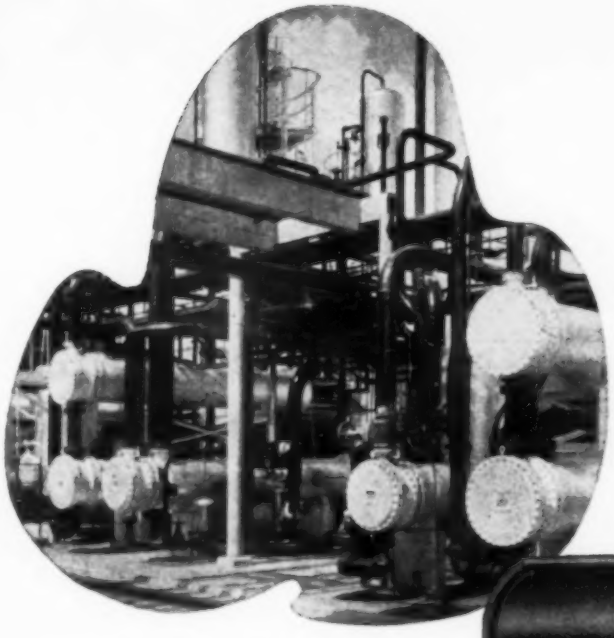
Sarco Co., Inc., New York, has moved their head office to the Empire State Building.

Adhesive Products Corp., New York, has completed a new laboratory which will be under the direction of Dr. Benton Dales.

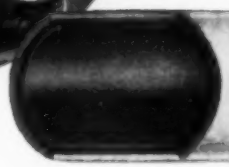
Fairbanks, Morse & Co., Chicago, has announced the appointment of L. A. Weom as manager of the pump division.

National Lead Co., San Francisco, has appointed W. C. Minsinger as industrial sales manager for the Pacific Coast, succeeding K. C. Specht, who has been made assistant manager of the firm's Southern California division at Los Angeles.

Goodyear Tire & Rubber Co, Akron, has named C. W. Thorp as manager of the Western district, with headquarters in Los Angeles, to succeed R. W. Fitzgerald. He will be in



BRIDGEPORT'S CONDENSER TUBE ALLOYS *To Combat* A VARIETY OF CORROSIVE CONDITIONS



DUPLEX TUBING—for double corrosive conditions—widely used in ammonia refrigeration and for heat exchangers and condensers handling a variety of chemicals. Available in copper base condenser tube alloys combined with steel, aluminum, stainless or monel either inside or outside.

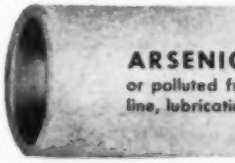
To withstand the corrosive conditions encountered in chemical plants, petroleum refineries, food and liquor processing, Bridgeport has developed a number of condenser tube alloys with specific properties.

Through extensive field and service tests and a coordinated program of laboratory research, Bridgeport has acquired the experience necessary to assist in making the proper selection. For individual consideration of *your* corrosion problem, contact the nearest Bridgeport office. Write for our 112-page Condenser Tube Manual.

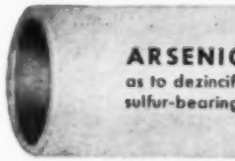
CUPRO NICKEL—Used for handling caustic and other alkaline liquids, salt solutions, sea water and numerous gases.

DURONZE IV** (aluminum bronze)—exceptionally resistant to hot brine in salt refineries; polluted sea and brackish water, and gives fine service against corrosive liquids in many processing industries.

CUZINAL (aluminum brass)—especially suited for marine installations where aerated sea water is circulating medium, since it offers high resistance to air impingement corrosion.



ARSENICAL ADMIRALTY—widely used for handling sea water or polluted fresh water, hydrocarbon gases containing sulfur compounds, gasoline, lubricating oils, etc.



ARSENICAL MUNTZ*—has high resistance to sulfur attack as well as to dezincification from corrosive fresh or saline waters. Effective for handling sulfur-bearing oils and gases.

BRIDGEPORT BRASS COMPANY
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Condenser and Heat Exchanger Tubing

BRIDGEPORT BRASS

charge of all Goodyear sales activities throughout the 11 Western states, Alaska and Hawaii.

Menasco Mfg. Co., Burbank, Calif., announces the election of H. P. Nelson as executive vice president, general manager and a director of the company. Other directors are R. E. Gross, president of Lockheed Aircraft Corp., Whitley C. Collins, J. M. Templeton and John C. Lee.

Consolidated Engineering Corp., Pasadena, has recently appointed H. W. Ruby as manager of measuring and recording sales.

Harbison-Walker Refractories Co., Pittsburgh, Pa., has purchased the Louthan Mfg. Co. of East Liverpool, Ohio.

McKinsey & Co., New York, has opened a Chicago office at 208 South LaSalle Street under the direction of Harrison A. Roddick and Frank Wallace.

Standard Oil Co. of N. J., New York, has named A. Bruce Boehm manager of Paramins sales of the Enjay Co., Inc. Irving E. Lightbown is now manager of rubber sales of the Enjay Co.

Carborundum Co., Niagara Falls, N. Y., has announced the completion of negotiations for the acquisition of land as a site for an extensive furnace plant at Vancouver, Washington.

Taylor Instrument Co., Rochester, N. Y., has elected Herbert J. Noble to the position of executive vice president and assistant general manager.

Link-Belt Co., Chicago, has appointed Albert Musschoot assistant to the chief engineer with headquarters at the general office in Chicago.

Givaudan-Delawanna, Inc., New York, has appointed William H. Wallace vice president of Givaudan-Canada, Ltd.

Shell Chemical Corp., New York, has named J. G. Frye district manager with headquarters in Chicago.

Owens-Illinois Glass Co., Toledo, Ohio, has appointed Harlan Hobbs sales promotion manager of the Kimble Glass division. Kimble Glass has moved its headquarters from Vineland, N. J. to Toledo.

Hammel-Dahl Co., Providence, R. I., has appointed Clarke Sales Engineering Co., Decatur, Ga., as their dealer representative in their Southeast territory.

CONVENTION PAPER ABSTRACTS

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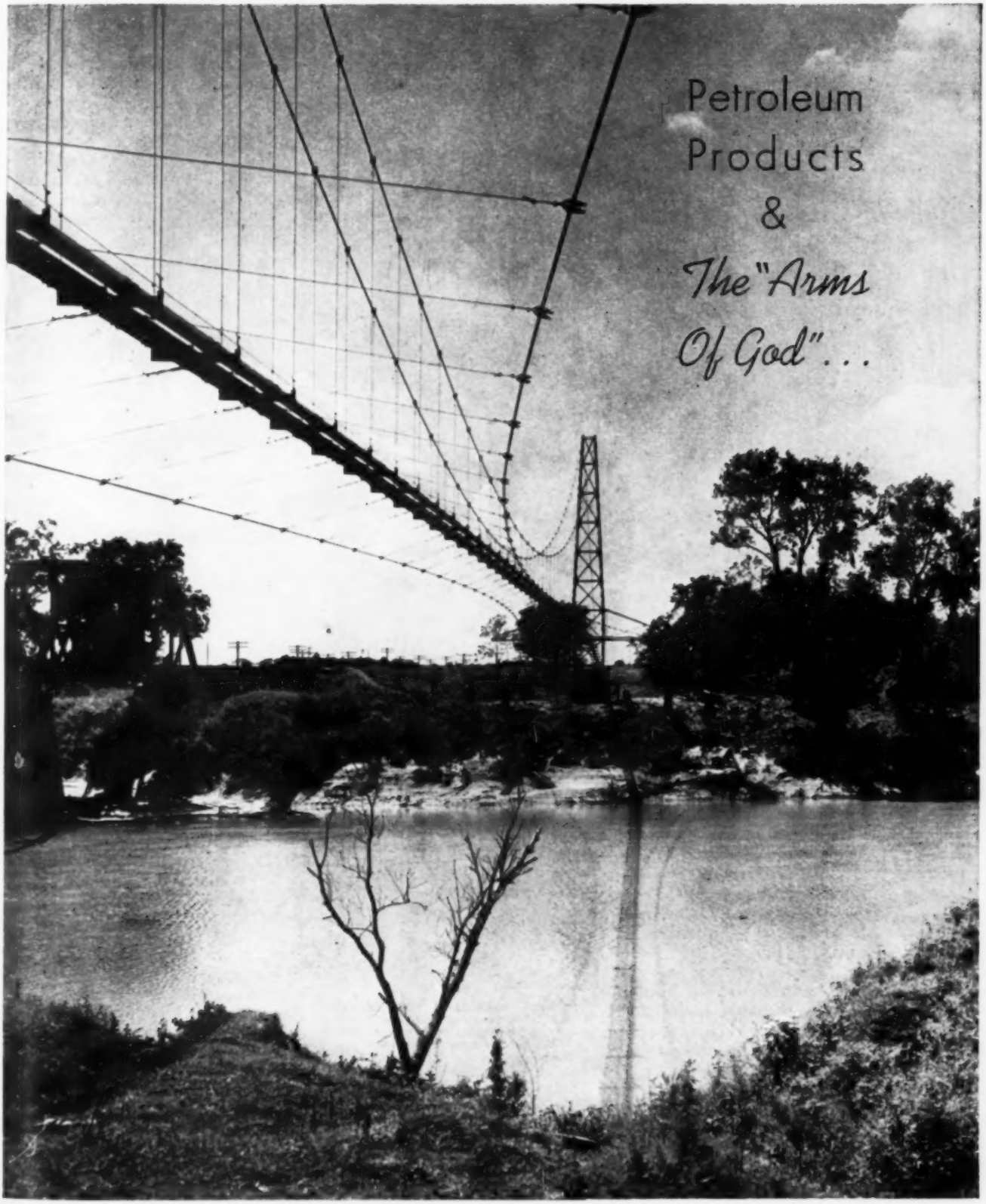
Improved Finishes

ALL types of finishes, household paints, industrial coatings, maintenance and special purpose paints; varnishes, lacquers and enamels already are better than those before the war and will improve still more as raw material supplies increase.

Two factors most important in this development are: synthetic resins, such as alkyd, and improved pigments. The alkyd resins (alkyd is a generic term made up of AL from alcohol and CID from acid, with the ci changed to ky for euphony) contain 30 percent phthalic anhydride, plus oil and glycerine. The importance of the alkyd resins lies in their controlability—the paint chemist is able to build his formula with an exactitude impossible with natural resins—and in their greater durability and color retention qualities. The need for a large volume of alkyds to supply coatings for war use led to development of a petroleum industry source of phthalic anhydride and to a much more plentiful supply of this crucial raw material. Phthalic anhydride, major raw material component of the alkyd resins, formerly was available only from naphthalene, a product of the coal tar industry.

The rapid development of pigments such as titanium dioxide is another major factor in improved coatings. Titanium dioxide, perhaps the whitest pigment known, comes from ilmenite, a black sand, and formerly was almost exclusively an imported war material, although part of the supply is now mined in the United States. The nation's supply of titanium dioxide, however, falls far short of the demand. Introduced in 1924 and subsequently improved in 1940, this pigment has four to six times the hiding qualities of other white pigments such as lithopone, zinc oxide, white lead and leaded zinc. When it becomes more plentiful,



Legend says Spaniards fleeing Indians in Texas long ago were saved when a sudden flood in a stream they had just crossed stopped the savages. Thankfully, they named the protecting river the "Arms of God," in Spanish, "Brazos del Dios," now shortened to Brazos. Modern Brazos floods seem heedless of whose path they block, but flow of petroleum products in the 8-inch line above will never the interrupted. Brown & Root, Inc. have bridged the Brazos near Sealy with a 625-foot (between towers) pipe line crossing of their design, fabrication and erection. Take your river problems to Brown & Root, Inc.

BROWN & ROOT, INC.

P. O. Box 2634, Houston, Texas

one-coat finishes will be possible where before two or three coats have been necessary.

Another development, the use of "bodied oils" is a direct result of the war. This term is used to describe oils which are heat treated to a high viscosity and then thinned according to formula. Known since the early days of the paint industry and used extensively by many paint makers in prewar enamels and other products, these bodied oils were more or less thrust upon the industry by the wartime necessity for conserving oils.

Prior to the war, heat bodied oils, chemically termed polymerized oils, were used in many formulas in quantities of roughly 5 to 10 percent heat bodied oils in a vehicle which contained 85 percent unbodied or natural oils. The government, however, required that formulas be changed to a ratio of one-third bodied oils to one-third unbodied and one-third thinner, thus extending the available supply of linseed and other oils. Paint producers discovered such formulas had values which had not been fully exploited and it is certain that polymerized oils will play an increasingly important part in paint products.

Still in the future are the newly developed silicones, which promise great things for heat-resistant enamels and lacquers. Now undergoing intensive experiment at all paint laboratories, these ingredients may alter major industrial coatings once the "bugs," including today's prohibitive costs, are ironed out.

Dwight P. Joyce, Glidden Company, Cleveland, Ohio, June 5, 1947.

Acetylene to Vinyl Resins

RECENT interest in acetylene as a chemical intermediate has had a surge upward with the return of our technical investigators from Germany. In America our petroleum resources have furnished a cheaper basic material for many of the same end products. For example, the German synthetic rubber industry depended upon butadiene made from acetylene, whereas American engineers utilized butadiene derived mainly from petroleum.

Sketching the chemistry involved: Vinyl acetate monomer is made by the addition of acetic acid to acetylene; polyvinyl alcohol by hydrolyzing polyvinyl acetate; polyvinyl acetals by reacting polyvinyl alcohol with the appropriate aldehydes; and vinyl ethers by the addition of alcohols to acetylene. Monomeric vinyl pyrrolidone may be prepared from acetylene and formaldehyde. To the best of my knowledge nobody in this country makes that material, but the Germans used a solution of polyvinyl pyrrolidone

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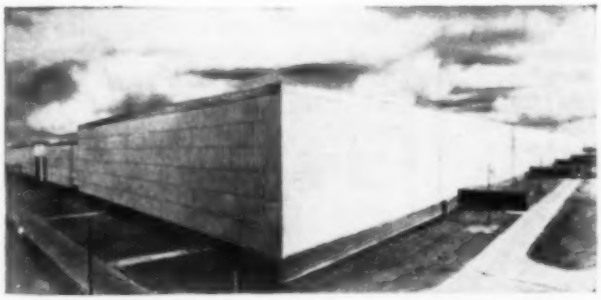
*Transite is a registered Johns-Manville trade mark

From smart shops on Main Street to gigantic "shops" of industry, Corrugated Transite is being used to streamline construction and reduce costs. Transite sheets can't rot . . . can't rust . . . can't burn



The corrugations in Transite increase the unusual strength of the asbestos-cement sheets—thus allow minimum framing. But the corrugations also serve as an important element of design in modern construction.

• The surprising news about Johns-Manville Corrugated Transite is not the fact that it is fireproof and weatherproof . . . or that it needs no preservatives, and practically no upkeep. Those and other advantages have already become widely appreciated through the years.

But look at the striking lines of the store front above . . . and the attractive, streamlined simplicity of the industrial giant shown at left. In both cases, versatile Transite provides *attractiveness* as well as utility. Yes, architects, engineers, and builders are discovering that Corrugated Transite lends itself effectively to modern design.

Use it on roofs or sidewalls . . . on both new or remodeled structures. Transite sheets are easily applied . . . cover large areas quickly because of their size . . . and can be completely salvaged when alterations are necessary.

Send for new brochure. Johns-Manville, Box 290, N. Y. 16, N. Y.

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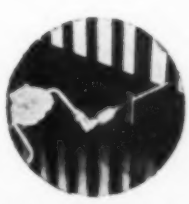
Because of unprecedented demand, there may be times when we cannot make immediate delivery. Please anticipate your needs.



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EASY TO SAW

EASY TO DRILL

EASY TO NAIL TO WOOD

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Johns-Manville *Asbestos* **CORRUGATED TRANSITE**

as a blood substitute. In battlefield transfusions amounts up to fifty percent of the blood content of the body were utilized.

Of the vinyl resins, the most important and largest volume group are the vinyl chloride resins. Vinyl chloride may be made by the following three different processes: (1) Dehydrohalogenation of ethylene dichloride by treatment with alkali; (2) the vapor phase cracking of ethylene dichloride; (3) the catalytic combination of acetylene and hydrogen chloride.

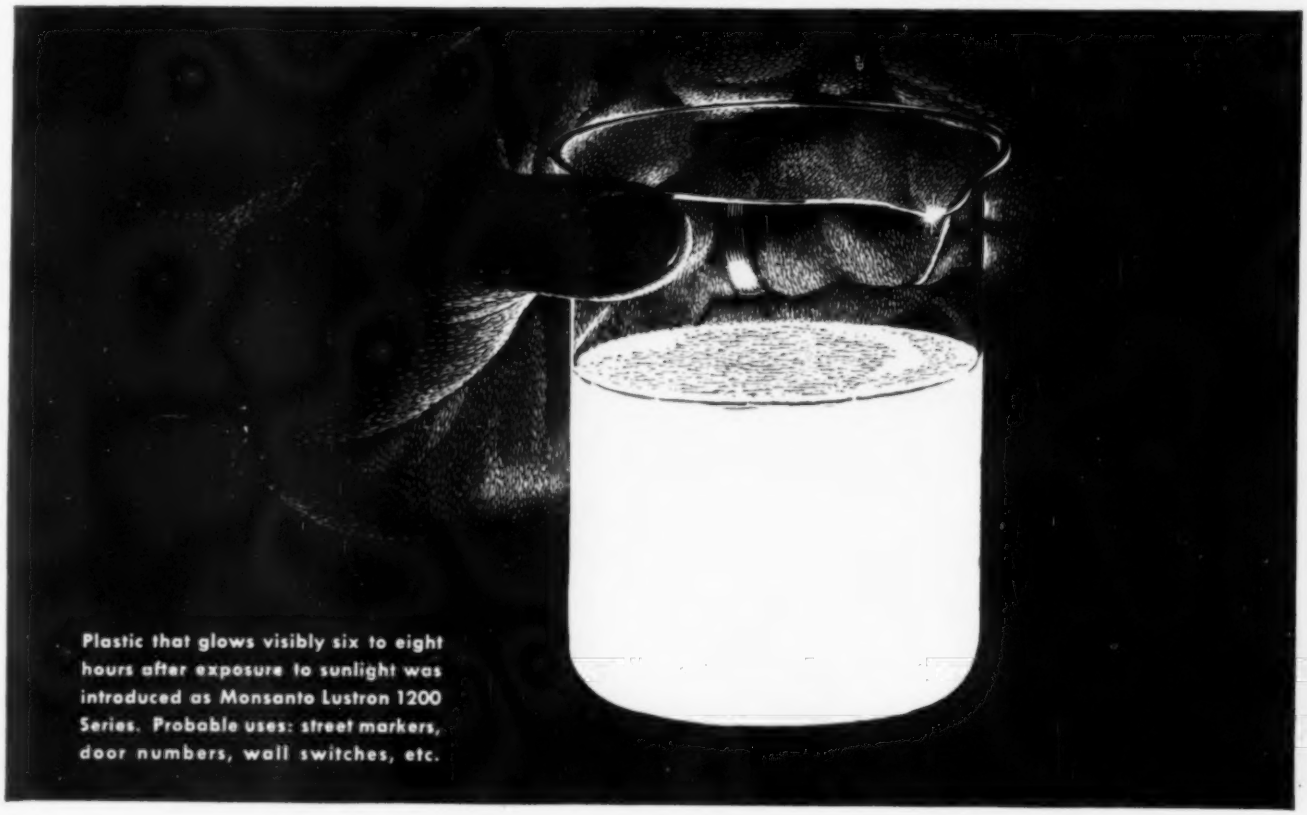
This vinyl resin business has taken a new turn with resin in a new form. When resin particles are suspended in water to form a milk-like latex, total solids of 50 to 60 percent are obtainable, as compared to 10-15 percent in a solution of resin. The particle size is extremely small, a fraction of a micron, ten times smaller than that of rubber latices. One advantage of vinyl resin latex, due to its small particle size, is the good impregnation it affords. A development which has broadened the usefulness of vinyl chloride resins for certain applications is the use of butadiene-acrylonitrile copolymer synthetic rubber to replace the conventional plasticizers in the plastic compound.

F. K. Schoenfield, Goodrich Chemical Co., before the International Acetylene Association, Cincinnati, Ohio, May 21.

Critical Chemicals

PETROLEUM is destined to play the number one role in overcoming the most perplexing basic chemical shortages now confronting our economy. Basic chemical shortages, are those which are not caused merely by short-term extra demand due to depleted inventories, pent-up consumers demand and momentarily high purchasing power or by longer-term factors such as inadequate production facilities, but those which arise when the demand for a given chemical outgrows not only the productive capacity but also the supply of the raw material from which it is made. Typical examples in this category of chemical shortages, are ethyl alcohol, methyl alcohol, phthalic anhydride, glycerine, and benzene or benzol.

While normally the development of new raw material sources acts as a break on chemical prices, permanent price reductions will not always be the result. While petroleum helped to bring market prices of toluene and the xylenes down, the time-worn ideas about buying benzene, the chemical, at the price of benzene, the fuel, need readjustment. Due to the spectacular increase in commercial demand for benzene the point is being reached at which the coal-tar distillers will have



Plastic that glows visibly six to eight hours after exposure to sunlight was introduced as Monsanto Lustron 1200 Series. Probable uses: street markers, door numbers, wall switches, etc.

"During the year we introduced 52 new chemicals"

—1947 ANNUAL MEETING, MONSANTO STOCKHOLDERS

THE HISTORY of Monsanto Chemical Company is one of almost uninterrupted growth. Beginning in 1901 with $5,000 of capital and one product, saccharin, Monsanto is today producing over 400 chemicals and plastics in some 20,000 formulations for over 40 basic industries.

Much of Monsanto's growth has occurred within the past ten years. In this short period, plant investment has risen from 31 to 108 million dollars, capital from $34,000,000 to nearly $84,000,000, sales from 28 to a current rate of 142 million dollars, employees from about 5,000 to well over 12,700.

"Organic chemicals are new industrial building blocks," says Edgar M. Queeny, Chairman of Monsanto Chemical Company. *In 1946 Monsanto produced a new chemical every week,* on average, to serve textile, food, leather, plastics, drug, agricultural, and electrical industries. Smith, Barney & Co., as investment bankers for Monsanto, have helped to provide funds to finance this great research job.

Continuing Research Program

Primarily, this expansion owes much to consistent, costly, and extraordinarily effective research . . . research which has already created new products, new industries, new jobs, in a chain reaction of its own. What new benefits mankind may derive tomorrow, in products, in wages, in richer, fuller living, can scarcely be guessed at.

Obviously, such great expansion has also required substantial financing. In these ten years of growth, the investment banking firm of Smith, Barney & Co. has been privileged to direct five important underwritings for Monsanto aggregating over 500,000 shares of preferred stock for a total amount of over 50 million dollars. From all viewpoints, it has been a development which we rate as true "creative financing."

"Creative Financing"

One of the largest firms in the investment business, Smith, Barney & Co. has handled underwriting and distribution of bonds, preferred stocks, or common stocks for many important enterprises, as well as private placement and secondary and special offerings.

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no more benzene to work off in motor gasoline, and it will not be long before the oil refiners will be selling instead of buying. Apparently this is no short-term inflationary price rise, but simply a case of a chemical which has been in over-supply for many years finding its demand catching up and bringing it up to the general price level of comparable products.

In contrast to benzene, a result of increased production of synthetic ethyl alcohol from petroleum, probably the present price will drop and stabilize within the next year or two in the 30-40c. per gallon range, at which firm level the American economy will profit by the further development and growth of the many industries to which this is a vital intermediate or solvent. Synthetic methyl alcohol, will also soon be available in plentiful supply at a reasonable price. This item, is expected to displace ethyl permanently for such uses as anti-freeze. As far as solvents are concerned, supply is catching up fast and bringing with it a reasonable and stable price structure.

In the field of finishes (paints, varnishes, lacquers, enamels and coatings of all types) there is a real ring-tailed shortage of the basic type with respect to phthalic anhydride. This synthetic chemical is one of the primary constituents of alkyd resins and the raw material from which it has traditionally been made has been naphthalene, a coal-tar product. However, today it is pretty well recognized that, although everything is being done to increase the recovery of naphthalene from coal-tar, the amount needed simply is not there and a new source of phthalic anhydride must be found. The answer to this problem has been provided through the manufacture of phthalic anhydride from ortho-xylene, a component of gasoline, and phthalic producers are now converting over from 100 percent naphthalene operation as fast as they can. From the very outset ortho-xylene has been made available at a price only slightly above the coal-tar by-product value for naphthalene so that the chemical industry can report with some pride that the day has been saved for alkyd resins as far as phthalic anhydride is concerned.

J. Oostermeyer, Shell Chemical Corp., before the National Association of Purchasing Agents, New York, N. Y., June 3, 1947.

To The Top

TOP RANK in industry was attained ten to twenty years after graduation from college by 43 percent of the technical executives covered by a recent survey. Thirty-one percent of the executives whose careers were studied

took twenty to thirty years to reach their present positions, and 18 percent waited thirty years or longer, while only 8 percent rose to important posts in less than ten years.

The magic and glamour surrounding the work have been largely removed by the public's familiarity with technical miracles, and the scientist or engineer who wants to succeed had better resign himself to a long period of hard work. One way in which the technical man can accelerate his progress is to develop scientific salesmanship.

Successful selling of scientific ideas is important for two reasons: (1) it means that the results of the work can be made of value to the organization; (2) his own progress is dependent upon successful selling that will make superiors feel confidence in him.

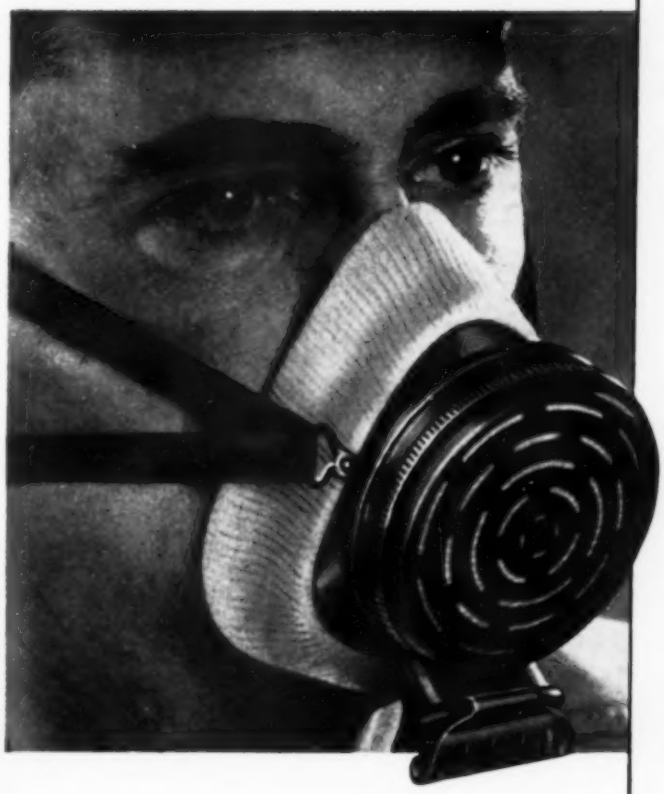
Although the technical man should be aggressive and should stand up for his own ideas and convictions, he must recognize the need for cooperation in an industrial organization. The new employee is advised to cooperate enthusiastically in carrying out assignments, even if they are not to his liking. And he should realize that chances of by-passing the boss are usually about nil—it is better to help him get ahead.

Morris T. Carpenter, Standard Oil Co. (Indiana), before the Kansas City Section, American Chemical Society, Kansas City.

Supersonic Testing

EQUIPMENT may be tested supersonically without damage to any part and very often without any disassembly. When metals are tested supersonically the depth of penetration may be as great as 25 ft. and there is essentially no lower limit to the size of flaws which may be found. The term "supersonics" or "ultrasonics" is used to refer to those frequencies of vibrational waves which are above the range of normal hearing.

The Supersonic Reflectoscope utilizes these vibrations by generating a short pulse of electrical energy. This pulse is then applied to a quartz crystal which has a characteristic of changing electrical energy into mechanical vibration at a frequency which is determined by the crystal and by the instrument itself. The crystal is then applied to the work and these vibrations are transmitted into it and travel through it. This quartz crystal is used not only as the sending element, but also as the receiving element, and when a mechanical vibration is impressed on it, the crystal has the property of transforming this vibration into electrical energy. In normal operation the pulse which has been sent into the material travels until it is reflected



NEW AO R-2000 RESPIRATOR with Chemically Treated Filter

PROTECTS AGAINST DUSTS 24 MILLIONTHS OF AN INCH IN DIAMETER

First of its kind, the R-2000 RESPIRATOR features a chemically* treated felt filter of approximately five inches which does the work of previous filters eight times as large in area — and protects workers from poisonous dusts as small as 24 millionths of an inch diameter! This new and important development safeguards against a *combination of all dusts* — toxic, nuisance and pneumoconiosis-producing, while providing increased front and side vision due to reduced size of the filter container.

The advance in filtering efficiency is without any increase in low breathing resistance and the compact overall size of the respirator offers a new high in wearer comfort. For added economy, the disposable filter is equipped with a gauze pre-filter which extends filter life by preventing the passage of larger particles of dust and dirt. A special lightweight easy-to-attach face shield is available for use with the respirator. This shield protects eyes and upper face against impact of foreign particles. Approved by the Bureau of Mines.

*Provides 40 to 1 greater efficiency over untreated filters.

Safety Division

American Optical COMPANY

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from an interface, from which it returns to the crystal. The crystal transforms the reflected pulse back into electrical energy which is applied to an amplifier and then to a cathode ray tube. Since the velocity of propagation of supersonics in any one material is constant, the elapsed time will always be the same for any specific distance travelled. Thus a pulse traveling through a piece of material to the opposite side will return in a given time. If there is a flaw in the path, the pulse will be reflected from the flaw before the opposite side; it will therefore travel a shorter total distance and the time of travel as indicated by the cathode ray tube will be correspondingly less. The observer therefore knows that there is an interface between the crystal and the opposite side. This interface must be a discontinuity. The cathode ray tube is calibrated in distance and no calculations or interpretations are necessary to read it.

Benson Carlin, Sperry Products, Inc., before the Joint Production and Chemical Committee Conference, American Gas Association, New York, N. Y., June 2, 1947.

Industrial Research Organization

RETURNS on research are generally not realized until a considerable period of time has elapsed, but if research is carried out intelligently and methodically over a sufficient period, it is possible to compute the return in the form of profits to the company and its stockholders. No research and development effort worth its salt can be conducted unless the personnel have intelligent, ingenious ideas on how to solve the problems. Too, one of the easiest ways to spur the generation of ideas is to encourage personnel to have a broad knowledge of other apparently unrelated fields of technical development and it is partly for this reason that plentiful use is made of consultants whose principal experience has been outside our own industry.

Nothing spurs a research and development team to greater endeavor than to have a competitor appear with some important new improvement. In process development such external competition is more difficult to see, since the process work on which a competitor is engaged frequently does not become known until several years after its completion. In my company we have adopted the practice of stimulating competition between our own research and development units. Frequently we practice duplication more theoretical than real, between individual laboratories, not only because the approach to a given problem in different laboratories varies, but also

because we have found it possible to secure a real competitive urge through assigning to different units different phases of a given project.

Avoiding practices which tend to discourage ideas is equally important. Any sudden and drastic shrinkage in technical personnel, for example, will result in losses of morale and effectiveness out of all proportion to the saving thereby achieved.

Normally, about three-fourths of a research and development budget is made up of salaries and directly related items, materials amount to another 12 or 15 percent and depreciation, rent, travel, and general expenses account for most of the rest. In my own company we make up a project budget each year by first fixing the total number of people to be utilized and then risking a guess as to how their efforts are to be divided among our major fields of effort.

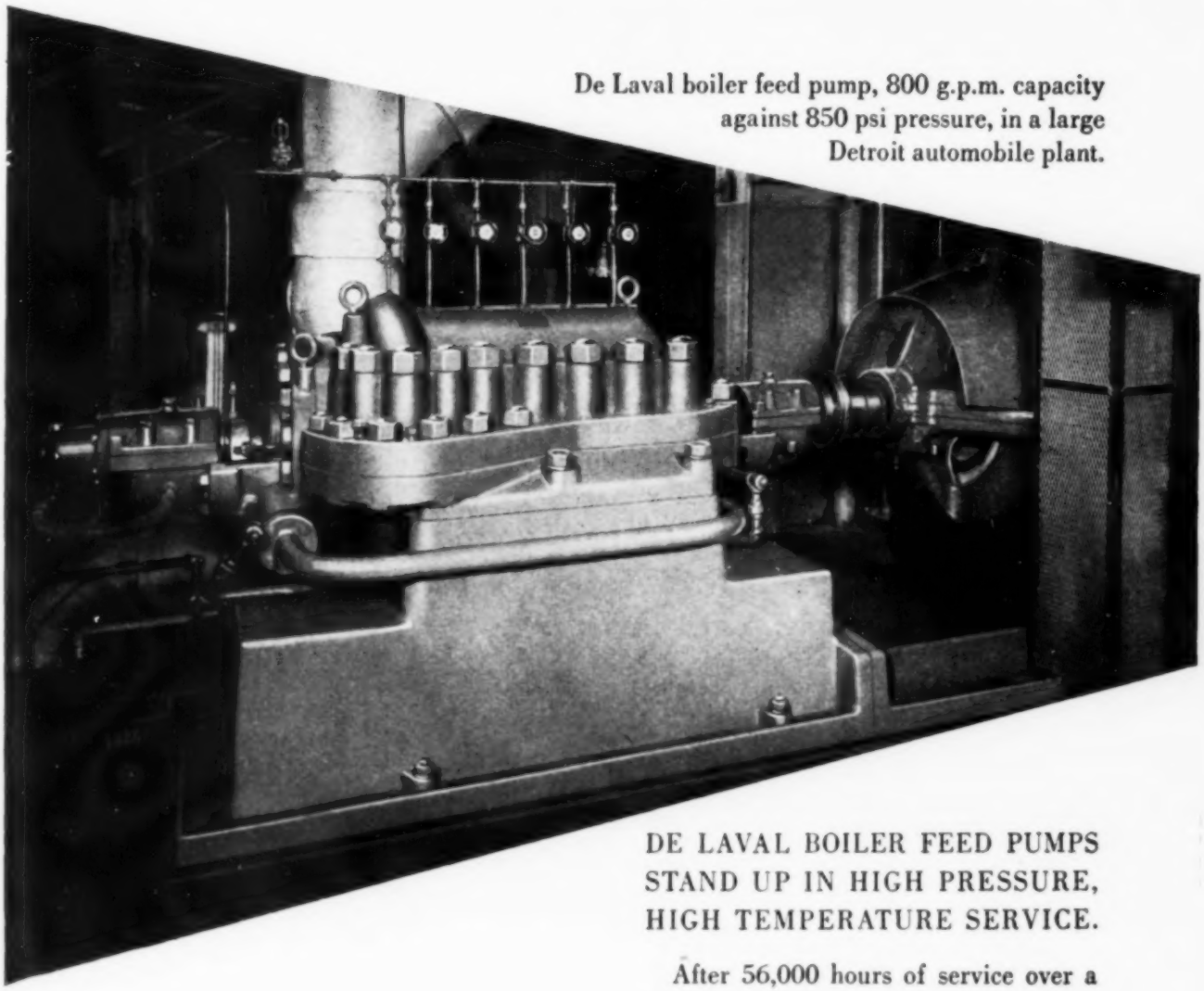
Robert P. Russell, Standard Oil Development Co., before the Federation of British Industries, London, England, June 9, 1947.

Executive Incentives

THE PROBLEM of providing sound incentives to executive effort in business has not received the intelligent and constructive consideration that its importance deserves. Fundamentally speaking, the whole problem reduces itself to the discovery and application of such principles and techniques as will cause the recipients of compensation to acquire full confidence in the validity of the processes by which their remuneration is determined.

Any constructive approach to the establishment of the base salary as an incentive is predicated upon the existence of the following conditions: (1) A soundly devised organizational structure which affords free play for the unfolding of executive capacity; (2) a comprehensive scheme of base salary ranges whose expressed values are in direct proportion to the varying degrees of responsibility present. One rather definite drawback is inherent in all base salary plans, however carefully devised. The regularity which attaches to their operation is apt in the long run to create in the minds of beneficiaries a feeling that such plans confer vested rights upon them which take precedence over the reciprocal obligation to equate values received with services rendered. It is for this reason that the device of contingent extra compensation has been introduced to create a supplementary stimulus which, combined with base salary provision, may be counted upon to exert a powerful influence in the direction of sound motivation.

Perhaps one of the most valuable by-products of the operation of a plan



De Laval boiler feed pump, 800 g.p.m. capacity against 850 psi pressure, in a large Detroit automobile plant.

"IN EXCELLENT CONDITION after 56,000 hours"

reports inspector

DE LAVAL BOILER FEED PUMPS STAND UP IN HIGH PRESSURE, HIGH TEMPERATURE SERVICE.

After 56,000 hours of service over a period of nine years, the power plant superintendent of a large Detroit automobile manufacturer asked for an inspection of this pump. The inspection was made and the following report received.

"We completely disassembled the pump and found wheels, diaphragms, shaft, bearings and all other parts in excellent condition. There was no washing of the pump case or any kind of corrosion. The shaft sleeve was highly polished. Balance parts including labyrinth leak off and the leak off bushing over the discharge end of the shaft sleeve hubs had but .005" wear."

In every detail De Laval pumps are designed for long trouble-free service.

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of contingent extra compensation is the fact that, when properly adjusted to all of the variables inevitably encountered, it may be expected to exercise a deterrent effect upon the elevation of base salaries to levels of burdensome proportions. Ultimate success will be most readily attained if the problem of compensation is resolved along lines looking to unification of the three major elements: Base salary, extra compensation and retirement allowance.

Finally, it is the factor of leadership that is bound to count most heavily in the long run when the question of incentive is brought to consideration. Perhaps the greatest return that can come to the chief executive will be paid him in personal satisfaction when he has developed a plan for motivating his fellow-executives to the realization of their highest potentialities.

Harry A. Hopf, Hopf Institute of Management, Inc., before the American Pharmaceutical Manufacturers' Association, Boca Raton, Fla., April 30, 1947.

FOREIGN LITERATURE ABSTRACTS

Kinetics of Oxidizing and Reducing Potentials

STUDY was made of the different factors affecting the kinetics of the formation of equilibrium oxidizing-reducing potentials of the system Tl^{+++}/Tl^{+} on hydrogenated electrodes. Time-potential curves were made to determine the rate at which the equilibrium potentials of the oxidizing-reducing system $Tl_2(SO_4)_3$, Tl_2SO_4, H_2SO_4 are established on the smooth hydrogenated platinum electrodes. The heterogeneously catalytic reaction is the one that determines the time. The rate of reaction is affected by the activity of the electrode, the presence of the adsorbed oxygen accelerating the reaction and the impurities passivating the electrode. Reproducible kinetics curves were obtained on the deactivated electrodes from the surface of which oxygen had been removed. Stirring of the electrolyte had no material affect on the rate of electrode reaction. It was found that there was an increase in the rate of electrode reaction with an increase in the concentration of the Ox.-form of the system. The reaction period varies with a change in the form, according to the equation $\tau_p = aC_{ox}^{-n}$. The rate of reaction within the investigated range is independent of the Tl_2SO_4 concentration in the solution. Dilution decreases the reaction rate similarly to the Ox.-form. An in-

tent are very resistant to corrosion. Paints with a medium content of chlorinated rubber still have fairly good chemical resistance. Those with a low content are still less resistant to chemical agents but they are also much less expensive. The presence of chlorinated rubber assures good resistance to atmospheric agents and even salt air as well as satisfactory surface hardness. The addition of just a small quantity of chlorinated rubber to an oil paint makes it possible to get a shorter drying time with greater hardness and some chemical resistance. In general, chlorinated rubber paints are characterized by their stability on exposure to water and chemical agents, their resistance to petroleum distillates and other derivatives, their non-flammability. They can be applied by brush, immersion or air brush. They are not resistant to high temperatures, so that the temperature should not exceed 70 deg. in a humid atmosphere, and 100 deg. in a dry atmosphere. The solubility of chlorinated rubber in cheap solvents makes it economical to use, and its solubility in non-flammable chlorinated hydrocarbons makes it possible to prepare paints which are entirely non-flammable, both at the time of application and after drying.

Digest from "Chlorinated Rubber" by Pierre Henry, *Recueil des Conferences, Journee Lyonnaise des Matieres Plastiques*, April 19, 1947, 29-53. (Published in France.)

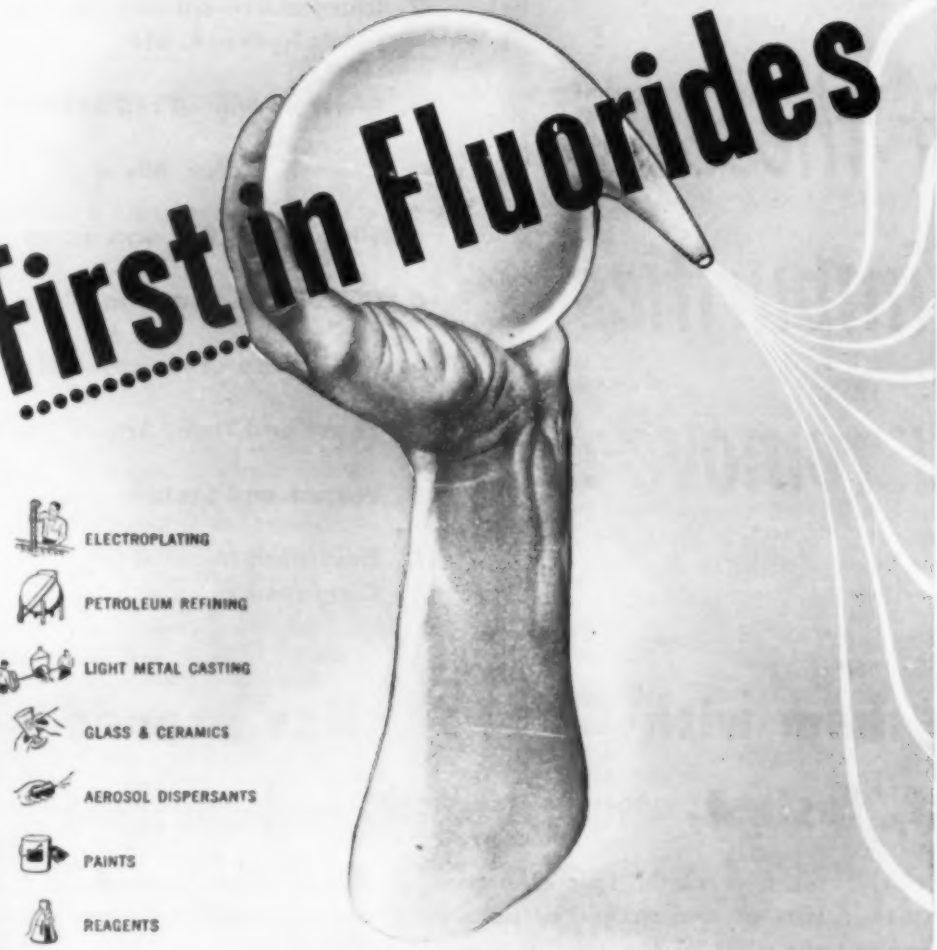
Pentachlorophenol for Wood Preservation

PENTACHLOROPHENOL is an antiseptic with strong fungicidal and insecticidal properties. Its vapor tension is high and it is stable to heat. It is resistant to rain since it is very little soluble in water. It does not stain wood, so that it can be painted afterwards, and does not give it a disagreeable odor. A solvent must be used to provide sufficient penetration of the pentachlorophenol. A product of petroleum distillation, of the fuel oil type, is most suitable. It has little color, is lighter and purer than the fuel oil known in France. It is well to add a glycerin resinate to the oil solvent so as to avoid superficial crystallization and prevent subsequent absorption of moisture by the wood. The concentration of the solution used to get protection varies from 1 to 5 percent. Pentachlorophenol has a suffocating and lacrymatory action and is irritating to the skin. It keeps this irritating property when dissolved in oil, but it can be reduced by addition of a solution of 1 to 4 percent borax.

Digest from "Use of Pentachlorophenol and Sodium Pentachlorophenate in the Preservation of Wood", *Rev. Bois* 1, No. 4, 21-24, 1946; *Chimie et Industrie* 57, No. 4, 375, 1947. (Published in France).

GENERAL CHEMICAL COMPANY

First in Fluorides



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- PETROLEUM REFINING
- LIGHT METAL CASTING
- GLASS & CERAMICS
- AEROSOL DISPERSANTS
- PAINTS
- REAGENTS
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- METAL CLEANING
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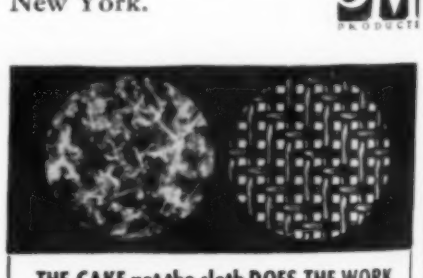

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CHEMICAL ENGINEER'S BOOKSHELF

Lester B. Pope, ASSISTANT EDITOR

Texas City Documented

THE SHIP EXPLOSIONS AT TEXAS CITY, APRIL 16 AND 17, 1947, AND THEIR RESULTS. *By George Armistead, Jr., Chemical Engineer, Washington, D. C.* 157 pages.

Reviewed by S. D. Kirkpatrick

ONE OF the first and most comprehensive reports on the Texas City disaster to come to our attention is that prepared by George Armistead, Jr., of Washington, in association with R. N. Blaize and J. L. Armstrong of Houston, Texas, for the oil insurance underwriters, John G. Simmonds & Co. of New York City. It details a great deal of first-hand data on these explosions and resulting fires, particularly to establish whether and to what extent the oil and chemical installations, and their inherent hazards, at Texas City, were responsible for the large losses of life and property. Therefore, this study should prove useful to all engineers concerned with safety in the chemical and petroleum industries.

In well documented conclusions, the report points out that the ship explosions were the prime cause of the loss of life and destruction of property and that there is no creditable evidence to show that the fires and other destructions in the oil and chemical plants had any effects which extended outside the respective areas where such destruction had occurred. The oil and chemical plant facilities stood up remarkably well under the punishment of the terrific ship blasts. Only approximately 22 percent of the petroleum and other hydrocarbons stored within one and one-third miles of the blast were lost by fire and only about 13 percent of the storage capacity on the basis of barrels or number of tanks experienced fire, although much damage was suffered.

The report also emphasizes the conclusion that the mechanism of the ammonium nitrate detonations at Texas City, and the factors controlling the tendency of this material to detonate, are not yet clearly understood. Until the properties and sensitiveness of ammonium nitrate and its various mixtures with other materials are clearly demonstrated beyond reasonable doubt, the report holds that such material should be marked, shipped and handled as substances which will explode when exposed to fire and/or other conditions not yet defined.

The maps, charts, photographs and tabular data in this report will prove worthy of study by all chemical engineers.

A limited number of copies of the publication are available from John G. Simmonds & Co., Inc., 111 John St., New York 7, N. Y.

Mostly for Colleges

FUELS, COMBUSTION AND FURNACES. *By John Griswold. McGraw-Hill Book Co., New York.* 496 *pages.* $8.

Reviewed by Alfred H. White

PROFESSOR GRISWOLD tells us in his preface that the book is written for students who have a knowledge of chemistry, mathematics and physics equivalent to that of the third year of a university chemical engineering curriculum. It does not presuppose any previous courses in chemical engineering. The technology of the preparation of solid, liquid and gaseous fuels is described in a rather elementary manner and illustrated by flow sheets. The chapter on Combustion Stoichiometry opens with a brief discussion of mol units and the gas laws, but proceeds to a somewhat detailed discussion of humidification.

The theory of the combustion process is given rather advanced treatment, but the principles of thermodynamics and kinetics are presented in advance of their application. The design of gas burners is discussed quite fully and is preceded by a short discussion of fluid mechanics. The subject of heat transmission in furnaces is also given a theoretical introduction. Furnaces burning solid and liquid fuels for steam generation, oil cracking and selected metallurgical operations are treated descriptively. No discussion is given of combustion operations under pressure as in diesel or automobile engines.

The author recommends the omission of some of the material if the book is to be used as a text for third year students, and deferment of the advanced material to a graduate course. It will be especially welcomed by those who specialize in petroleum engineering.

RECENT BOOKS RECEIVED

Coating and Ink Resins. By W. Krumbhaar. Reinhold. $7.

The Guarantee of Annual Wages. By A. D. H. Kaplan. Brookings Institution. $3.50.

Grundlagen Der Eisengewinnung. By R. Durrer. A. Franke, Switzerland. s.fr. 20.

Handbook of Industrial Electroplating. By E. A. Oblard and E. B. Smith. Louis Cassier Co., London. 15s.

The Heat Treatment of Steel. By E. Gregory and E. N. Simons. Pitman. $4.

National Paint Dictionary. 3rd ed. By J. R. Stewart, Stewart Research Laboratory, Washington, D. C. $7.50.

Physical Chemistry. By E. D. Eastman and G. K. Rollefson. McGraw-Hill. $4.50.

Production With Safety. By A. L. Dickie. McGraw-Hill. $2.50.

Volumetric Analysis, Vol. II. 2nd ed. By I. M. Kolthoff and V. A. Stenger. Interscience. $6.

Wood Pulp and Allied Products. 2nd ed. By J. Grant. Leonard Hill, London. 35s.

Reference Volume

FATTY ACIDS, THEIR CHEMISTRY AND PHYSICAL PROPERTIES. *By Klare S. Markley. Interscience Publishers, New York.* 668 pages. $10.

Reviewed by Gordon W. McBride

AS THE AUTHOR points out in his preface, literature on fatty acid data is voluminous, widely scattered, and relatively unorganized. This book is designed "to bring together in an organized and readily accessible form as much as possible of the present accumulation of facts and data pertaining to the chemical reactions and physical properties of the fatty acids and, especially, of the long chain fatty acids which comprise the building stones of all natural fats, oils, and waxes. The material thus made available should obviate many hours of searching the literature by the large and growing body of chemists, physi-

cists, engineers and technologists who are interested in the fatty acids and their numerous products and by-products."

A brief introduction to the subject occupies the first ten pages of the book. Thereafter the volume is compactly filled with data and references. A 15-page author index and a 20-page subject index are included and should be very helpful to the chemical engineer using this book.

Five major subdivisions of the subject are treated by the author. The first of these deals with classification and structure of fatty acids, and occupies approximately 10 percent of the volume.

Physical properties of the fatty acids are the second major subdivision. This is broken down into crystal properties, spectral properties, thermal properties, solubility and solution properties and properties of the fatty acids in the liquid state.

Nearly half the book is devoted to chemical reactions of the fatty acids. These are broken down into esterification, alkylation, pyrolysis, halogenation, hydrogenation, oxidation and other major types of reaction. Nitrogen and sulphur derivatives are considered, and two chapters are devoted to autoxidation and biological oxidation.

The last two subdivisions of the book deal briefly with synthesis and isolation of the fatty acids. It is particularly in these latter categories that the author leaves the reviewer hoping that "the present work will result in the stimulation of qualified individuals to undertake investigations designed to fill the missing gaps in our knowledge of the subject and to re-examine those reactions and properties which obviously are in need of review." It is not unlikely that future volumes in the Interscience Publishers' "Fats and Oils" series will begin to fill those gaps.

Wartime Production

STRATEGIC MINERALS. *By John B. De Mille. McGraw-Hill Book Co., New York. 626 pages. $7.50.*

Reviewed by Raymond B. Ladoo

THE AUTHOR of this book, formerly senior engineer of the mining section of Reconstruction Finance Corporation, was connected with the war effort in Washington from October 1942 to July 1945. From this vantage point he was able to review in detail the phenominal progress of our industrial and mineral development during World War II.

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plies, allocate scarce materials to most urgent uses and regulate prices. The main chapter headings in general cover minerals and metals officially classified as "Strategic" or "Critical." But since the official classifications of "Strategic" and "Critical" minerals varied with the progress of the war, practically all industrial metals are covered, as well as such rare metals as palladium, osmium, iridium, rhodium, and ruthenium. Numerous non-metallic minerals are omitted, such as garnet, limestone and lime, gypsum, etc. Petroleum, coal, natural gas, natural asphalts, mineral waxes, etc. are also omitted. Topaz, relatively unimportant is inclined, but salt, the essential base for our alkali industries, is omitted.

During the critical war and post-war periods the author recounts in considerable detail the various orders, directives, regulations and ukases of W.P.B., O.P.A., B.E.W., F.E.A. and other governmental agencies which were intended to stimulate the war effort in the mineral industries. Stockpiling principles and practices, war time and post war, are outlined and data, where available, are given on domestic and foreign reserves. Treatment is historical rather than critical.

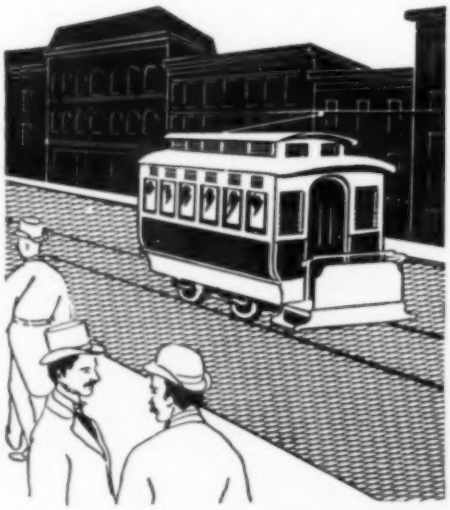
Section headings of a typical chapter are: Properties; Uses; Domestic Sources of Supply and Production; World Production, Imports and Exports; Prices; Selected References. All of these sections cover mainly the 1941-1945 war period.

While this work contains a great deal of useful information, the arrangement, choice of data and emphasis leave much to be desired. Unfortunately the "facts behind the news" are given in but few cases. This book is not for the layman. In very many instances a good working knowledge of the subject under discussion is needed to keep from going astray. For example, garnet and emery are treated as if they were synonymous. Another example: the typical North Carolina mica is made to appear as "hard, green 'black mica' (dark-stained muscovite) . . . suitable for stove fronts" etc., with no mention of the important place of North Carolina high grade sheet mica.

Under "Quartz Crystal Properties", he fails to describe the all important piezo-electric property upon which the strategic position of quartz depended. Yet in the "Quartz" chapter he includes a page on plastic optics, which are in no way related to oscillator plates, as well as space to non-critical uses of other forms of silica such as diatomite, tripoli and sand.

While many new, war-born processes and uses are noted he fails to emphasize and "point up" some of

BACK IN THE 1880's



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the most important and significant of these developments. For example, the geographically important steel mills built at Provo, Utah, and Fontana, California, are mentioned, but not a word about the iron ore deposits to supply them. At the same time, many incompetent, irrelevant and immaterial bits are scattered about in most unexpected places. One example: "Spodumene and lepidolite have been used largely for inflating life rafts." Graphite he calls "a critical rather than a strategic material", ignoring the anxious days in the summer of 1942, with Ceylon and Madagascar cut off, when graphite was close to the "No. 1 Strategic Mineral".

It is unfortunate that greater care was not used in obtaining precise, accurate information and in a more critical presentation of the material available.

GE's War Story

MEN AND VOLTS AT WAR. *By John A. Miller. Published by Whittlesey House, McGraw-Hill Book Co., New York. 272 pages. $3.75.*

Reviewed by S. D. Kirkpatrick

MOST companies, of necessity, have preserved some documentary evidence of the extent and character of their participation in World War II. Very few, however, have gone to the trouble and expense of having this material declassified from the standpoint of security and then presented in a comprehensive, readable story of industrial achievement. Yet some day all of us will probably regret that the record of America's industrial might is so fragmentary and incomplete.

We have Charles E. Wilson to thank for having recognized this need and having ordered all divisions of GE and associated companies to put this material in the hands of an able and experienced industrial editor. The result, in Mr. Wilson's own words "Is a story of hard work and long hours, but it is also a story full of drama, excitement and romance—a dynamic pattern woven by human hands and brains, fired by enthusiasm and tempered by organization."

It is probable that General Electric produced a greater variety of complex war equipment and was called upon to solve a greater variety of difficult technical problems than any other single manufacturer. More than 175,000 of its men and women were involved in this great effort. Part I of this book tells of their progress in making combat equipment—radar, ships, bazookas, etc. Part II tells of products for industry—from power plants to atomic energy and engineer-

ing. There are three useful appendices —Mobilizing Men and Machines, G. E. Plants and Their War Products, and Production Awards to G.E. Plants. Approximately a hundred interesting photographs add value to the record.

Scientific Spanish

ENGLISH-SPANISH CHEMICAL AND MEDICAL DICTIONARY. *By Morris Goldberg. McGraw-Hill Book Co., New York.* 692 *pages.* $10.

Reviewed by Alfredo Carranza

THIS invaluable new medical and chemical dictionary, in English-Spanish and Spanish-English, has just been printed. It contains the most important terms and definitions in medicine, chemistry, pharmacy, veterinary, dentistry, bacteriology and related sciences, as well as the names of scientific equipment. Many of the words (over two thousand) are not included in any similar book. Examples are new terms involved in the study of hormones, sulphonamide compounds and penicillin. Not only are Spanish equivalents given for English terms, but clear, concise definitions are included.

Child of Research

THE CHEMISTRY OF COMMERCIAL PLASTICS. *By Reginald L. Wakeman. Reinhold Publishing Corp., New York.* 836 *pages.* $10.

Reviewed by H. C. Parmelee

AFTER the dyestuffs industry became established as the marvel of organic chemistry, there were those who felt that no further great development would come from the organic field. But they reckoned without the brilliance of scientific research that resulted in the development of the plastics industry, the end of which is not yet.

This volume grew out of the author's own need, first when he engaged in research in this field, and later as an instructor and lecturer. Without pretending to cover the field completely, it correlates scientific knowledge of plastics with industrial practice, which makes it of exceptional interest to teachers, students and industrialists.

The history of the modern plastics industry began with Goodyear's discovery of the vulcanization of rubber, but in the realm of plastics of purely synthetic origin Baekeland's development of the phenolic resins was a new landmark. The phenolics are not only the oldest, but still the most versatile and most widely used in molding applications. But many others followed in their wake, as evidenced by more than fifteen chapters in the book de-

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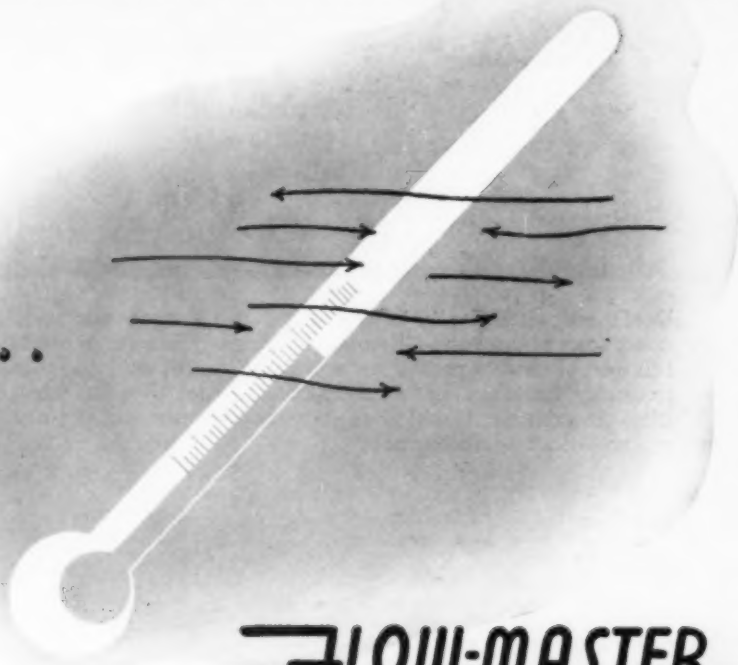

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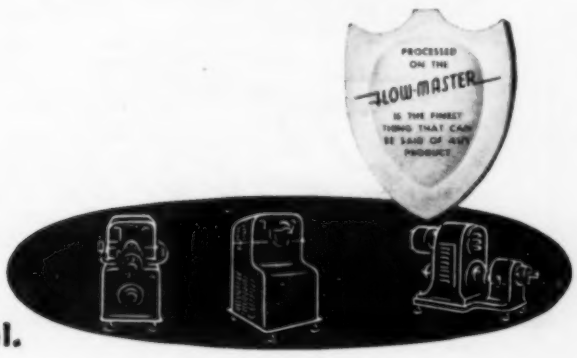

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voted to as many types of plastics. In each the author discusses the chemistry of the group and their industrial applications. The volume is unusually well indexed, with a subject index of thirty pages and a trade name index.

BRIEFLY NOTED

A Century of Silver. By Earl Chapin May. Published by Robert M. McBride & Co., New York. 388 pages. $3.50. Using the history of silver manufacture from 1847 to 1947 as a core, Mr. May has built up a picture that typifies the growth of all American industry during this time. From itinerant tradesmen to captains of industry the silversmiths progressed. The Connecticut silver towns, the large mass production factories and the modern methods of widespread distribution which evolved are all treated in detail here. Especially noted is the rise of the International Silver Co. and the relationship between modern production and human relations within it.

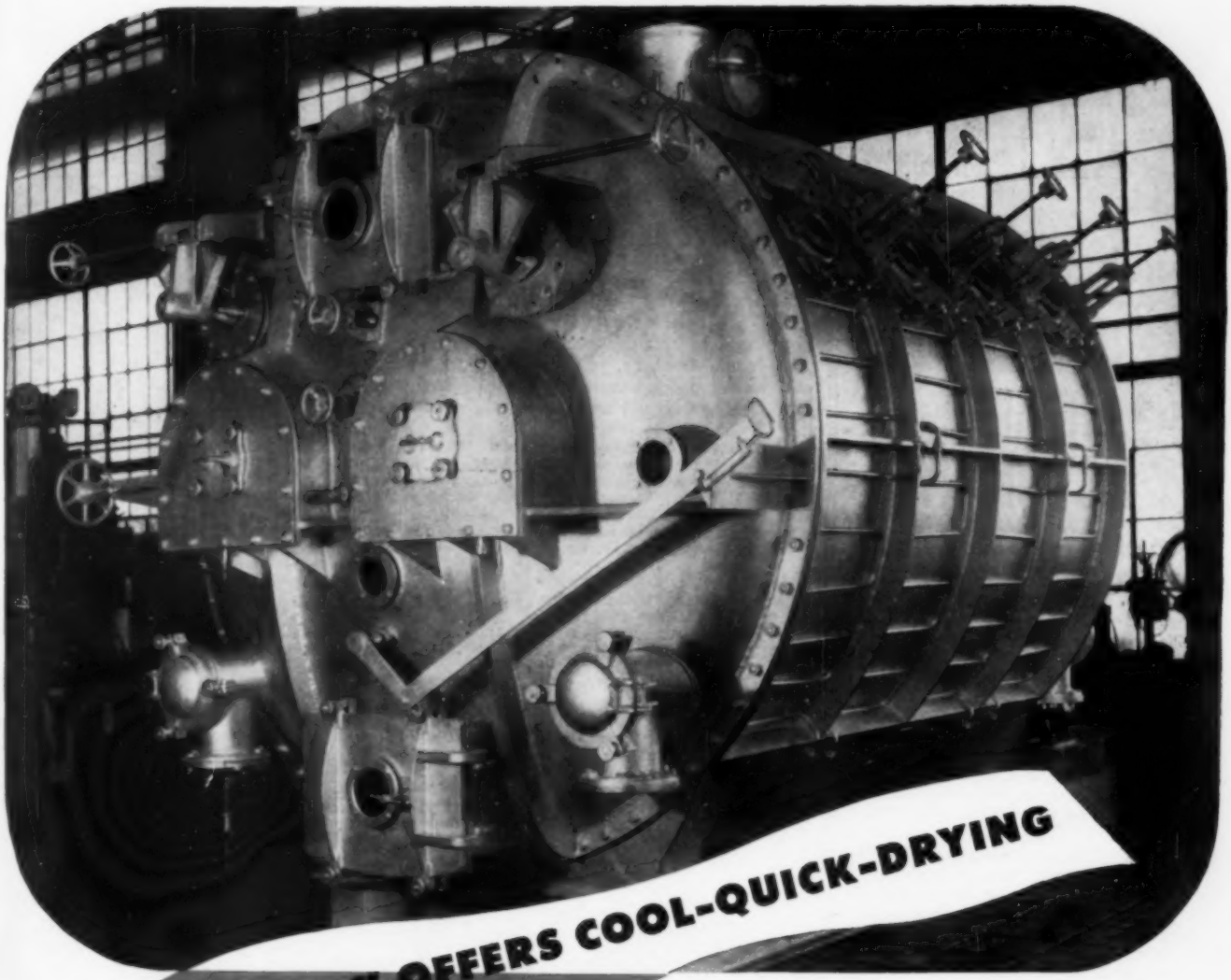
Lessons in Arc Welding. Third edition, published by The Lincoln Electric Co., Cleveland, Ohio. 158 pages. 50 cents. Supplemented by photographs, illustrations and drawings, these 58 revised lessons explain the fundamentals of joining metals by the fusion principle. In addition to treating welding with alternating and direct current are procedures covering large electrodes and their use, a number of lessons on pipe welding and data on the qualifications of welding operators.

Bibliography of Hydrocarbons Under Pressure. By D. L. Katz and M. J. Rzasa. Published by J. W. Edwards. 306 pages. $4. While developing laws and theories forty to sixty years ago, physicists and physical chemists investigated the behavior of organic compounds under pressure and published data on it. On the premise that this data forms the background for present day engineering calculations, the authors have placed emphasis on the period between 1860 and 1910. Articles of special interest to engineers in the field of petroleum and natural gas have been included. References in Part I are assembled by subjects in Part II to facilitate a literature search in any given field.

Manual of Sugar Companies, 1946. Farr & Co., New York, N. Y. 282 pages. $2. Describes the economic status of 27 sugar producing and refining companies. Presents statistical tables of sugar production, yields and prices.

Experimental Casting Plastics. By T. A. Dickinson. Published by Plastics Research Co., Alhambra, Calif. 30 pages. $2. Devoted to formulae and methods of making rigid or flexible patterns, molds and casts from plastics or for use in the connection with plastics, this little book is well supplied with photographs, drawings and bibliographical references.

Encyclopedia of Hydrocarbon Compounds, Vol. II-C_7 and C_8. Compiled by J. E. Faraday. Chemical Publishing Co., Brooklyn. $15. In this volume, the second in



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a series giving the occurrence, methods of preparation, physical constants and a solvent for recrystallization for hydrocarbon compounds, those compounds having seven and eight carbons are covered. As in the first volume, there is a loose-leaf arrangement permitting regular supplements to be inserted.

The Magic of Numbers. By Eric Temple Bell. Published by Whittlesey House, the McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 418 pages. $3.50. Mathematicians—especialy Pythagoras—and their influence on the development of religion, philosophy, science and mathematics.

GOVERNMENT PUBLICATIONS

The following recently issued documents are available at prices indicated from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. In ordering any publications noted in this list always give complete title and the issuing office. Remittance should be made by postal money order, coupons, or check. Do not send postage stamps. All publications are in paper cover unless otherwise specified. When no price is indicated, the pamphlet is free and should be ordered from the bureau responsible for its issue.

Synthetic Organic Chemicals, United States Production and Sales, 1945. U. S. Tariff Commission, Report No. 157, Second Series. Price 45 cents.

Short Harsh Cotton. U. S. Tariff Commission, Report No. 156, Second Series. Price 20 cents.

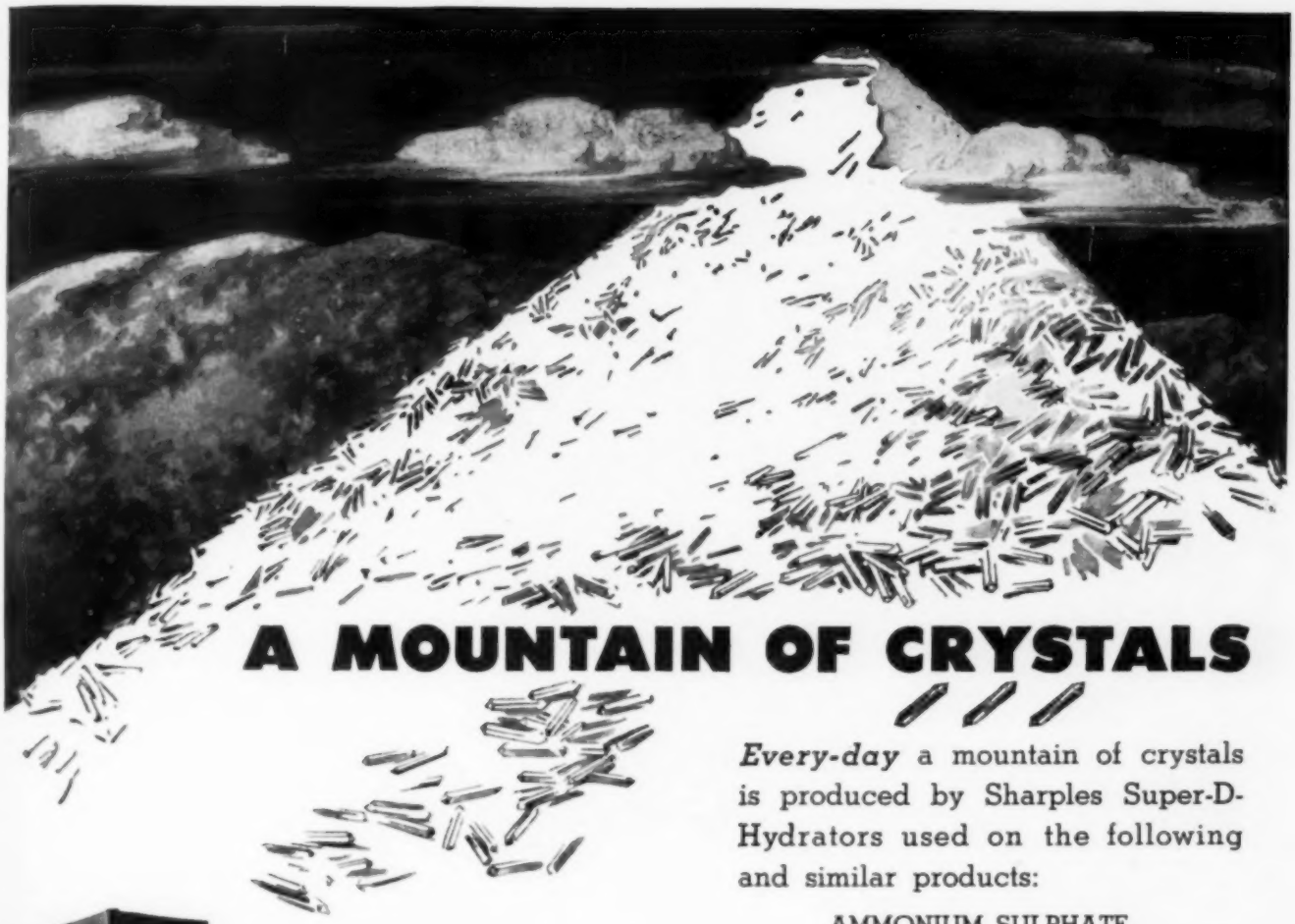
Science and Public Policy. Volume One. A Program for the Nation. The President's Scientific Research Board. Price 20 cents.

The President's Conference on Fire Prevention (7 reports): Action Program; Report of the Committee on Research; Report of the Committee on Fire-Prevention Education; Report of the Committee on Laws and Law Enforcement; Report of the Committee on Organized Public Support; Report of the Committee on Fire-Fighting Services; Report of the Committee on Building Construction, Operation, and Protection. Order from The President's Conference on Fire Prevention, Washington 25, D. C.

The Effects of Atomic Bombs on Health and Medical Services in Hiroshima and Nagasaki. The United States Strategic Bombing Survey, Medical Division. Price 45 cents.

Mineral Statistics. The Bureau of Mines has begun issuing the separate preprint chapters of Minerals Yearbook 1946. Those wanting the latest printed data should ask the Bureau for them, indicating specific commodities. No general mailing lists are maintained.

Approval of Newly Developed Self-Contained Breathing Apparatus, Instructions in Its Care and Use, and Training Procedure. By G. W. Grove and E. E.



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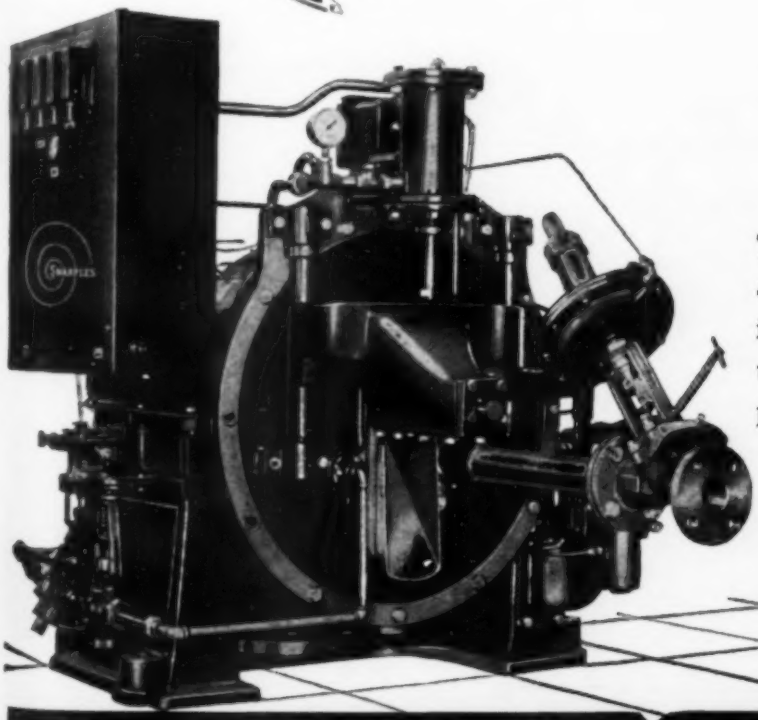

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EXECUTIVE OFFICES AND FACTORY, 2300 WESTMORELAND STREET, PHILADELPHIA 40, PENNA.

Quenon. Bureau of Mines, Information Circular I. C. 7413. Mimeographed.

Tungsten Deposits of Vance County, North Carolina, and Mecklenburg County, Virginia. By G. H. Espenshade. Geological Survey Bulletin 948-A. Price 50 cents.

A Glossary of the Mining and Mineral Industry. By Albert H. Fay. Reprint, without changes, of glossary first published in 1918. "This dictionary of technical and local terms relating to metal mining, coal mining, quarrying, metallurgy, and other mineral industries has helped to standardize the expressions and terms in common use by persons associated with these industries." Price $1.75.

Discussion of Industrial Accidents and Diseases. 1946 Convention of the International Association of Industrial Accident Boards and Commissions, Portland, Oregon. Division of Labor Standards, Bulletin 87. Price 35 cents.

Labor Laws and Their Administration, 1946. Proceedings of the Twenty-Ninth Convention of the International Association of Governmental Labor Officials, Milwaukee. Division of Labor Standards, Bulletin 88. Price 40 cents.

Directory of Labor Unions in the United States. Bureau of Labor Statistics, Bulletin No. 901. Price 10 cents.

Guaranteed Wage or Employment Plans. Bureau of Labor Statistics, Bulletin No. 906. Price 15 cents.

Economic Analysis of Guaranteed Wages. Bureau of Labor Statistics, Bulletin No. 907. Price 25 cents.

Bureau of Labor Statistics Chart Series, 1946. Price 75 cents. General economic data in chart form.

National Income and Product Statistics of the United States, 1929-46. Supplement to Survey of Current Business, July 1947. U. S. Department of Commerce. Price 25 cents.

Annual Report of Research and Technologic Work on Coal, Fiscal Year 1946. By A. C. Fieldner and P. M. Ambrose. Bureau of Mines, Information Circular I. C. 7417. Mimeographed.

State and Regional Market Indicators, 1939-1945. U. S. Department of Commerce, Economic Series No. 60. Price 20 cents.

Forest Service Reports. Available free from Forest Products Laboratory, Madison, Wis. No. 1561—Preliminary Report on the Strength of Flat Sandwich Plates in Edgewise Compression. By Kenneth H. Boller. No. 1573—Durability of Low-Density Core Materials and Sandwich Panels of the Aircraft Type as Determined by Laboratory Tests and Exposure to the Weather. By Bruce G. Heebink, et al. No. R1671—Small Demountable-Type Lumber Dry Kiln for Eperimental Drying. By O. W. Torgesson. No. R238—List of Publications on Chemistry of Wood and Derived Products. No. R454—List of Publications on Wood Finishing Subjects. No. R-704—List of Publications on Wood Preservation. No. R1666-7—Synthetic Board Materials and Molded Products from Wood Waste. By J. P. Hohf, et al.

Role of Potash in Growth and Nutrition of Maryland Tobacco. By J. D. Bowling and D. E. Brown. Department of Agriculture, Technical Bulletin No. 933. Price 10 cents.

Preliminary Tests of Synthetic Organic Compounds as Insecticides. Part III. By G. T. Bottger and Clemence Levin. Bureau of Entomology and Plant Quarantine, E-729. Processed.

MANUFACTURERS' LATEST PUBLICATIONS

Chemical Engineering's Reader's Service, in cooperation with manufacturers, makes it possible for you to secure catalogs, bulletins, and other publications herein listed without obligation (unless a price is specifically mentioned). For your convenience, publications may be obtained by using Reader Service Coupons on pp. 163-164.

(Continued from page 164)

what the equipment is designed to do together with the mechanism of its operation.

114. Adhesives. National Adhesives, 270 Madison Ave., New York, N. Y.—A brochure entitled "Successful Case Sealing" describes the use of synthetic resin adhesives for domestic and export case sealing.

115. Tools. Ampco Metal, Inc., 1745 South 38th St., Milwaukee 4, Wis.—Catalog 118. 28-page booklet picturing and giving dimensions for this company's line of safety tools made of aluminum bronze, beryllium-copper and high nickel alloy. An 8-page price list is inserted.

116. Copper Plating. Metallurgical Products Co., Philadelphia, Pa.—A series of five pocket-sized folders presenting helps for the electrotyper and the electroplater. They include a chart covering the cause and correction of electro forming, the hydrometer method of analyzing copper sulphate, volumetric analysis of copper, correction for concentration in acid copper baths and chemical calculations.

117. Pumps. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin 08B6615. 4-page folder describing a new line of centrifugal pumps manufactured by this company. Includes a cross-sectional picture showing features of construction. Diagrams and tables give dimensions.

118. Instruments. Brown Instrument Co., Philadelphia, Pa.—2-page nomograph with directions for its use. The nomograph is designed to determine correct sighting angles and locations for radiation measurement of high temperatures.

119. Equipment. Sprout, Waldron & Co., Muncy, Pa.—8-page bulletin illustrating and describing the line of process equipment made by this company. Size reduction, mixing and blending, pelleting, supplementary equipment and materials handling are covered.

120. Stainless Steel. Empire Steel Castings, Inc., Reading, Pa.—2-page data sheet on the line of stainless steel alloys manufactured by this company. Discusses the chemistry, mechanical properties and heat treatment of the alloys. Includes a graph showing the relation between corrosion in nitric acid, quenching temperature and carbon content of cast steels.

121. Resins. American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N. Y.—Illustrated four-color booklet describing the laminating resins manufactured by this company. Applications and potential uses for these plastics are presented.

122. Chemicals. L. Sonneborn Sons, Inc., 88 Lexington Ave., New York 16, N. Y.—Two bulletins, "Current Topics No. 84 and No. 85," on the uses of this company's petroleum products in the leather industry.

123. Filters. Hardinge Co., Inc., 122 East 42nd St., New York, N. Y.—4-page folder describes the automatic backwash sand filter made by this company.

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Another Advancement in Packaging

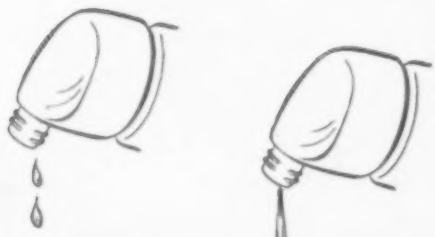
B&A HYDROFLUORIC ACID, *Reagent A.C.S.*

Exclusive *SAFTEPAK* PLASTIC BOTTLE
maximum utility • maximum safety

Two years ago, Baker & Adamson pioneered plastic containers for its Reagent A. C. S. Hydrofluoric Acid. Thus, it eliminated for all time the hazardous old-fashioned wax bottle for HF so long in use by the chemical industry. This package met with immediate success and widespread acceptance, for it answered a long-felt need of laboratory chemists.

Now, with new advancements in plastics themselves, Baker & Adamson has developed a still finer container—its exclusive new *Saftepak* bottle. This offers the combination of special pouring and sealing features outlined, which provide maximum utility and protection in laboratory use. Study them carefully, then order your Reagent HF requirements from B&A today . . . and be among the first to enjoy the advantages of the exclusive *Saftepak*. It is readily available from convenient shipping points, coast to coast.

† Trade Mark, General Chemical Co.



1 Outstanding Pouring Control

Now pours drops, needle stream, or full flow, depending on your requirements.

Accurate measure . . . "siphon-action" pour-out draws back into bottle any drops clinging to lip when pouring stops.

Translucent . . . acid level always visible.

Easy to handle . . . the *Saftepak* with its sturdy encircling label band fits conveniently into your hand for easy pouring.

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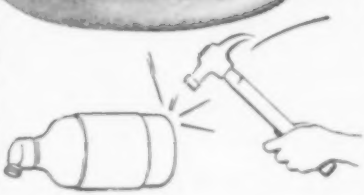
Entire unit made of special plastic highly resistant to aqueous HF.

3 Shatter-Proof

Bottle is pressure molded of shatter-proof plastic . . . does not become brittle, crack or break as do ordinary wax containers. Will not shatter or smash even under heavy impact.



4 Screw-Tight Cap

Provides easy reclosure; safeguards against possible spillage or leakage; protects Reagent A. C. S. purity of the acid.

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SETTING THE PACE IN CHEMICAL PURITY SINCE 1882

* Complete stocks carried here.

Diagrams a typical plant layout. Contains a well-labeled cross-sectional drawing showing construction and operation of their filter. Diagrams rectangular and circular clarifiers which can be used with the unit.

124. Chemicals. Union Bay State Chemical Co., Cambridge, Mass.—Two booklets entitled "The Properties and Uses of Some Novel Organic Peroxides" and "Tank Lining Compound for Corrosion Proofing" discussing the chemicals made by this company. The first covers the manufacture, physical properties, and the effect of these peroxides in polymerization reactions. The second contains information about this company's tank lining applications. Includes also tables of chemical resistances.

125. Paint. The New Jersey Zinc Co., New York 7, N. Y.—12-page booklet discusses the progress of the paint industry. Describes various types of paint and how they may be put to the best use.

126. Instruments. Fisher Governor Co., Marshalltown, Iowa.—Bulletin F2406, 8-page booklet describes this company's instrument for recording and indicating liquid levels. Includes a page of graphs showing performance. Discusses mechanism and applications.

127. Insecticides. Orbis Products Corp., New York, N. Y.—6-page folder describes the Rotenone resins made by this company. Gives methods of application and formulas for preparation of oil concentrates and garden sprays.

128. Waterproofing. Ranetite Mfg. Co., 1917 South Broadway, St. Louis, Mo.—12-page booklet illustrating the uses of this company's cement waterproofing compounds for basements, tunnels, dams, tanks, silos, and roofs.

129. Chain Drives. Link Belt Co., Chicago, Ill.—16-page booklet describes this company's Link-Belt 3/16 in. pitch silent chain. Contains dimensions of sprocket wheels, horsepower ratings and examples of calculations of chain drive centers.

130. Rotary Connectors. Perfecting Service Co., Chicago 37, Ill.—Catalog No. 350. 12-page booklet contains well-labeled digrams showing the design of the ball bearing Rotary Union manufactured by this company. Includes dimension charts and engineering data.

131. Magnetic Pulleys. The Eriez Manufacturing Co., Erie, Pa.—8-page leaflet describes and pictures the operation of this company's non-electric permanent magnetic pulley. Contains chart showing the material factors for determining pulley size. Another shows capacities, dimensions and weights.

132. Gravity Conveyors. The Rapids-Standard Co., Inc., Grand Rapids 2, Mich.—24-page booklet describes the line of wheel and roller type gravity conveyors made by this company. Contains detailed views of the conveyers and their accessories and their application to handling. Specifications for the various models are listed.

133. Filters. American Air Filter Co. Inc., Louisville, Ky.—Bulletin No. 210. 8-page booklet explains the application of replacable type air filters for ventilating and air-conditioning systems. Each model is described and illustrated. Contains instructions for maintenance and engineering installation data.

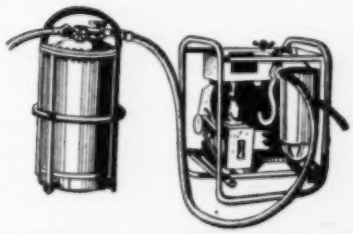
134. Materials Handling. Automatic Transportation Co., Chicago, Ill.—8-page folder pictures and describes this company's Transtacker, a lifting and loading machine. Cross-sectional drawings and text explain specifications. Shows examples of its application.

135. Equipment. Pacific Coast Engineering Co., Oak at Clement St., Alameda, Calif. Bulletin PC-20. A 6-page bulletin describing briefly and illustrating the types of custom-built process plant steel equipment and machinery designed and fabricated by this firm. Includes tanks, cookers, sterilizers, presses, towers, values, heat exchangers and other items for the chemical, petroleum, rubber and other process industries.

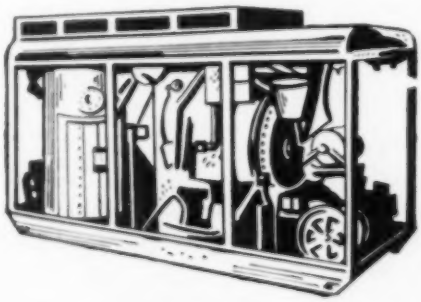
136. Plastic Coating. Carboline Co., 502 North Taylor, St. Louis 8, Mo.—4-page leaflet discussing the Vinaline plasticized

Army and Navy surplus—some used, some unused. Many sizes and types of Water Purification, Chlorination and Distillation units available at bargain prices.

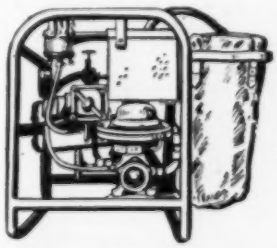
If you have not yet received your copy of the booklet pictured above, send for it today; it contains illustrations and descriptions of many available units other than those shown on this page, and tells where this equipment is located.



PORTABLE WATER PURIFICATION UNIT (MOBILE)—Consists mainly of a pumping unit and a filter unit. The water is cleaned by harmless chemicals. Forcing water reversely through the filter washes the unit thoroughly.



WATER DISTILLATION UNIT—Some units are trailer mounted, fully equipped with tires, ready to move to the working location; other units are portable— neat, compact and mounted on skid-type frames. Unit consists of a gasoline engine, steam compressor and other parts and necessary piping, all assembled and mounted on a structural steel base.



HYPO-CHLORINATION UNIT (AUTOMATIC)—Chlorinates from 2 to 100 gallons of water per minute. Unit consists of hydraulic operated hypochlorinator, water meter, pressure regulating valve and manual range adjusting valve.

For copy of booklet and details of current sales address any WAA Customer Service Center, mentioning sales Programs A-78 and A-79.

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Offices located at: Atlanta • Birmingham • Boston • Charlotte • Chicago • Cincinnati • Cleveland • Denver • Detroit • Grand Prairie, Tex. • Helena • Houston Jacksonville • Kansas City, Mo. • Little Rock, Ark. • Los Angeles • Louisville • Minneapolis Nashville • New Orleans • New York • Omaha • Philadelphia • Portland, Ore. • Richmond Salt Lake City • St. Louis • San Antonio • San Francisco • Seattle • Spokane • Tulsa

1314

Customer Service Centers in these and many other cities.

FOR MORE INFORMATION
See Reader Service Coupon on pages 163-164

synthetic coating made by this company. Covers uses, application to metal and concrete, chemical resistance and mechanical and physical properties. Provides a page of price estimates.

137. Fire Extinguishers. Pyrene Manufacturing Co., Newark, N. J.—8-page pocket sized folder picturing and describing the anti-freeze and water type fire extinguishers made by this company.

138. Belting. B. F. Goodrich Co., Akron, Ohio—2-page catalog leaflet describes the construction of the V-Belt made by this company. Carries a page of data giving standard stock sizes.

139. Rubber Lined Steel. Metalweld, Inc., Philadelphia Pa.—4-page bulletin presents facts about rubber lined steel and other protective coatings in industry. Features tables giving resistance characteristics of rubber linings to inorganic acids, inorganic salts, alkalis and organic materials. Includes data on their chemical, abrasion and temperature resistance.

140. Emulsifying Agents. Griffin Chemical Co., 1000 16th St., San Francisco, Calif. Three 1-page sheets describing the uses, physical characteristics, and solubility of this firm's "Trex 40" emulsifier for use with DDT solutions, "Trex 80" solubilizer for use with chlordane, and S-polymers for applications where resins with low moisture permeability are required.

141. Wetting Agent. American-LaFrance-Foamite Corp., Elmira, New York.—4-page leaflet discussing this company's compound for increasing the spreading and penetrating qualities of water.

142. Ion Exchange. Liquid Conditioning Corp., Linden, N. J.—4-page folder illustrates a plant set-up for demineralizing sugar-containing juices. Discusses treatment of other process liquids.

143. Resins. Bakelite Corp., New York 17, N. Y.—4-page folder discussing the general characteristics of this company's the "Vinylite" Resin VMCH. The properties of this resin are compared with those of others made by this company.

168. Hexaethyl Tetraphosphate. Eston Chemicals, Inc., 3100 E. 26th St., Los Angeles 23, Calif. Bulletin 7. A 3-page report summarizing briefly the observed and reported results of the use of hexaethyl tetraphosphate in West Coast agricultural areas. Gives dosages and results on truck and field crops, citrus trees, apples and pears, grapes, and miscellaneous crops.

145. Gas Machinery. The Gas Machinery Co., Cleveland 10, Ohio.—Bulletin A-200. 4-page folder on this company's twin generator oil gas process. Contains a diagram. Illustrates and describes method of operation, cyclic processes and gas analysis.

146. Sintering Hearths. The Mace Co., Denver 5, Col.—12-page catalog gives information on this company's models of sintering hearths for agglomeration, blast roasting, volatilization sintering and chemical technology. Contains pictures and drawings showing various models and their operating principles.

147. Electrostatic Painting. Harper J. Ransburg Co., 1204 Barth Ave., Indianapolis 7, Ind.—16-page booklet illustrating typical electrostatic spray installations made by this company.

148. Engineering Design. Design Service Co., Newark, N. J.—22-page booklet touching on the services this company can provide in the fields of industrial and process engineering.

149. Fire Protection. Factory Insurance Assoc., Hartford 2, Conn.—16-page

Built to stand up under 24 hour a day service

● Type H Heavy Duty Worm Gear Reducers driving 54-in. and 48-in. tumbling mills in steel foundry. Ratio 11-1/3 to 1 and 7-3/4 to 1.

TODAY every phase of production work calls for drives that will stay on the job. Jones Worm Gear Speed Reducers have been built for long, trouble-free service. And the records established by these speed reducers in 24 hour a day service show that they have the ruggedness and stamina for which all Jones Transmission Products are known.

For complete information on Jones Worm Gear Speed Reducers ask for Bulletin No. 68 and for Worm-Helical Reducers ask for Bulletin No. 75.

● Jones Worm-Helical Speed Reducer driving a lacquer agitator. A simple design prevents leakage of oil along the vertical low speed shaft.

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CUT GEARS • V-BELT SHEAVES • ANTI-FRICTION PILLOW BLOCKS • FRICTION CLUTCHES • FLEXIBLE COUPLINGS

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Jones Worm Gear Reducers are built in ratios from 4 to 1 up to 90 to 1 and in capacities from ¼ to 100 H.P.

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booklet picturing and describing the methods and equipment recommended by this association for controlling fires.

150. Safety Equipment. Safety Clothing & Equipment Co., Cleveland, Ohio.—86-page catalog listing and describing safety clothing and equipment put out by this company. Includes such items as asbestos, leather and rubber gloves and clothing, helmets, face shields, belts, grinding shoes, machine guards, and acid-handling equipment.

151. Plastics. E. I. duPont de Nemours & Co., Arlington, N. J.—12-page booklet illustrating the uses of the various plastics products made by this company. Describes Lucite, polythene, nylon, cellular cellulose acetate, Butacite and Teflon.

152. Expansion Joints. Zallea Bros. and Johnson, Wilmington, Del.—60-page catalog describing in pictures, text and diagrams this company's various types of expansion joints and connectors. Contains reference data and information on the selection of expansion joints for given applications.

153. Reinforced Hose. American Ventilating Hose Co., New York 7, N. Y.—6-page pocket sized folder featuring spiral wire reinforced hose for handling air, gases, dust and other airborne materials under pressure or vacuum.

154. Electrical Equipment. I-T-E Circuit Breaker Co., Philadelphia 30, Pa.—52 page catalog includes a section on the selection and application of the low voltage air circuit breakers made by this company. Contains tables on such subjects as air circuit breaker types and ratings, protective devices available, average ampere ratings of motors and transformers full load and interrupting capacity current values.

155. Instruments. Oilfields Service Co., 529 E. Roosevelt Road, Long Beach 7, Calif. 6-page bulletin on this electronic instrument designed to measure the thickness of ferrous and non-ferrous materials by using the principle of the penetration of gamma rays. Discusses design features, applications and limitations. Illustrated.

156. Welding. Niagara Machine & Tool Works, Buffalo, N. Y.—12-page booklet describes and pictures the action of the electronic automatic welding machine made by this company. Contains a capacity chart for the standard model.

157. Furnace Equipment. National Airoil Burner Co., Inc., Philadelphia 34, Pa.—Bulletin No. 65 contains sixteen pages describing the line of low air pressure oil burners and centrifugal blowers manufactured by this company. Pictures the various models and describes their operation. Presents tables giving dimensions, weight and pressure data.

158. Quality Control. North American Philips Co., Inc., New York 17, N. Y.—8-page booklet divided into two sections entitled "Charts Help Diagnose Quality Progress" and "How to Analyze Production Rejects." Contains drawings and tables.

159. Fish Processing Machinery. Standard Steel Corp., 5001 Boyle Ave., Los Angeles, Calif. Catalog 602. 16-page bulletin describing and illustrating the complete line of equipment put out by this firm for the handling and processing of fish, including meal and oil. Includes data on cookers, presses, grinders, hashers, dryers, foots recovery machines, oil settling tanks and separating systems.

166. Check Valves. Grove Regulator Co., 6529 Green St., Oakland 8, Calif. Bulletin 610A. 6-page folder describing and illustrating the features and applications of this firm's "Chexflo" valves designed to overcome sticking and other difficulties commonly experienced with ordinary check valves. Contains data on construction and operating principles, dimensions and specifications.

167. Paint Finishing Systems. Peters-Dalton, Inc., Detroit 12, Mich.—Bulletin No. 501 contains 12 pages picturing and describing highly specialized paint finishing systems designed by this company for the automotive industry. Covers systems for metal preparation, spray painting, baking and drying, and metal cleaning and rust proofing.

CHEMICAL ECONOMICS

H. M. Batters, MARKET EDITOR

INCREASED CALL FOR CHEMICALS FOLLOWS RISE IN ACTIVITIES AT CONSUMING PLANTS

PRODUCTION of chemicals as measured by the index numbers of the Federal Reserve Board was on a rising line in the first half of this year with the number moving up from 430 for January to a revised level of 440 for June. The index dropped to 436 in July with some improvement expected for August and September. Current reports indicate that important consuming industries entered the final quarter with an appreciable gain over the July lows.

Petroleum refining did not follow the general trend throughout the summer months. Runs to stills are making new records and estimated requirements for oil are constantly being revised upwards. The Bureau of Mines has issued four separate estimates of 1947 requirements and each revision has placed the total at a higher figure. That this is not a temporary trend is indicated by the fact that the Bureau believes 1948 requirements will run about 5 percent above the present estimate for 1947.

Sales of fertilizer tax tags in August were at an all-time high for that month and from industry reports regarding the current movement of fertilizer materials there is good reason to believe the industry will reach the high objective it has set for the 1947-48 season. In the war period, fertilizer outputs moved to new highs with each succeeding year and there still is a long way to go before industry capacity will be taxed. However, capacities for turning out basic raw materials have not always proved adequate and even with new installations now in operation, it is held that availability of materials may prove to be the most important factor in limiting the rate of progress.

Textile mills, particularly the cotton branch of the industry, have been running considerably below the rates maintained earlier in the year but began to gather momentum in August and that trend is continuing. Use of synthetic fibers has been growing. Production and shipments of rayon are of record proportions and with further additions to capacities in prospect, the industry seems destined to forge steadily ahead for a long time to come.

Latest available data for chemicals cover operations in July and show a mixed situation with smaller outputs reported for some products and increases for others. July production was the highest for any month of the year to date for acetic acid, acetone, ethylene glycol, phenol, toluol, carbon dioxide, natural soda ash, and tri-basic sodium phosphate. Considerable progress has been made in bringing the supply of chemicals up to the level of consuming requirements but many still are in the scarce category and promise to continue so into next year.

Consumption of rubber fell off in June and July, but total consumption for the first seven months of the year of 650,293 long tons was almost 14 percent higher than in the corresponding period of 1946. A breakdown of the 1947 total credits 351,229 long tons to synthetic rubber and 299,064 long tons to the natural product. It is noted, however, that natural rubber is steadily winning a large part of the market. Consumption of reclaimed for the seven months was 168,638 long tons and 152,441 long tons respectively.

Shipments and consumption of plastics and synthetic resins as reported by the Bureau of the Census, dropped a little below 60 million pounds in July which is a continuation of the trend set in recent months. The decline was fairly general throughout the various classifications although the vinyl group showed but little change from June. Any slowing up, however, is regarded as temporary.

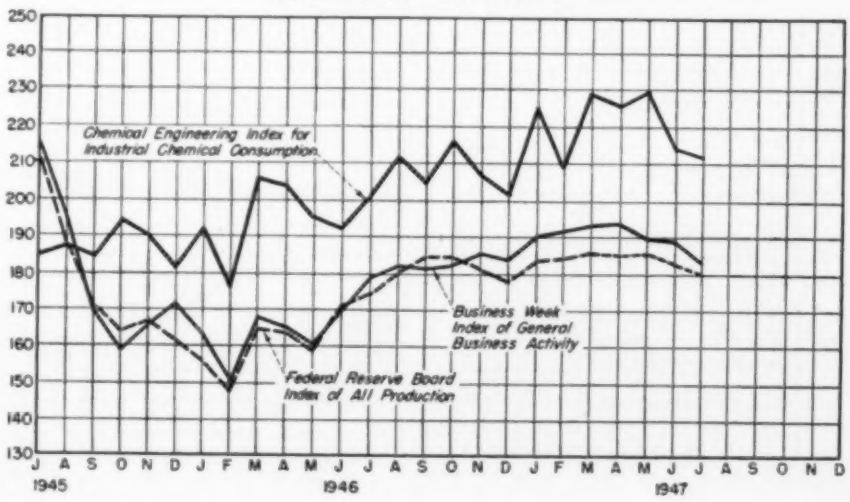
Improvement in supplies of fats and oils have enabled the Department of Agriculture to more than double its export quota over that set for the third quarter but a part of the new allocation is in the nature of a reciprocal arrangement whereby this country is to receive other oils and fats in exchange. The large new domestic crop of flaxseed has improved the outlook for linseed oil but marketing of seed has been slower than anticipated.

Crushing of oil-bearing materials in July accounted for 618,802 tons or a little under the figure for June. Of this total soybeans accounted for more than 400,000 tons.

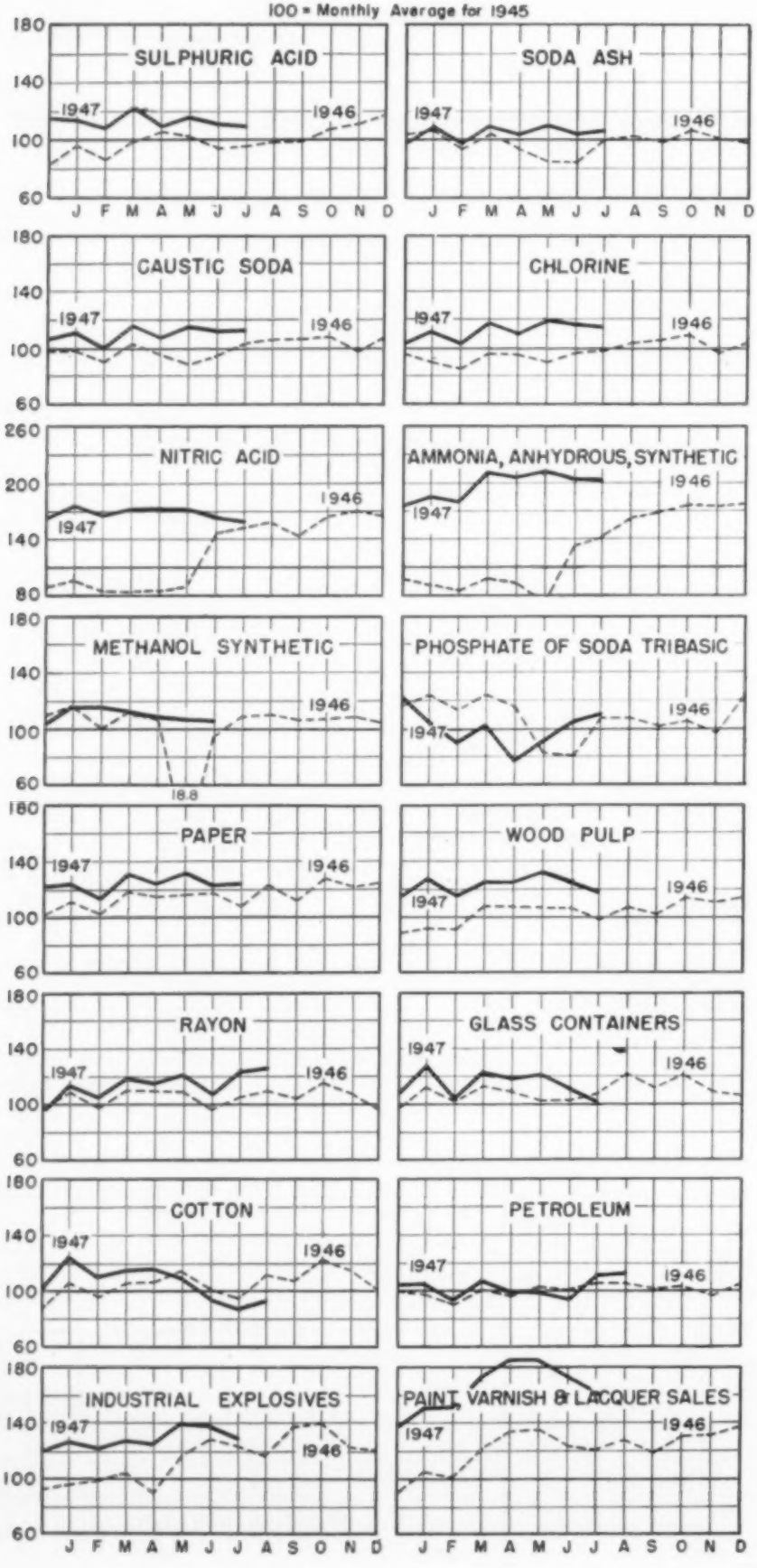
Chemical Engineering Index
Industrial Consumption of Chemicals

1935 = 100

	June Revised	July
Fertilizers	47.97	47.95
Pulp and paper	22.35	21.27
Petroleum refining	19.94	20.93
Glass	21.62	20.06
Paint and varnish	25.60	24.30
Iron and steel	12.70	12.16
Rayon	20.56	23.99
Textiles	10.05	9.70
Coal products	9.87	9.10
Leather	4.60	4.60
Explosives	7.47	6.90
Rubber	5.35	5.05
Plastics	6.48	6.14
	214.56	212.15



PRODUCTION AND CONSUMPTION TRENDS



Throughout the first half of this year, prices for chemicals fluctuated within very narrow limits. In the resale market, an era of high prices started late in 1939, the basis of exchange climbing as more and more difficulty was met in securing stocks. This situation has not changed to any extent and it is noteworthy that the important chemicals which have long been in short supply and which scored the sharpest price advances in second-hand dealings, were held by producers at practically unchanged price levels throughout the war years and right up to recent months.

Beginning with third quarter deliveries the market began to take on a firmer price appearance and numerous upward revisions were made in sales schedules. This movement has been gaining ground and several more chemicals were marked up for October forward positions. Hence it is evident that a rising price trend has set in with the probability it will not be reversed until there has been a decided change in basic conditions involving labor and raw material costs. The extent to which values have advanced may be inferred from the fact that the increases apply to such heavy tonnage items as soda ash, caustic soda, chlorine, many chlorinated products, coal-tar chemicals, bichromates, and dyes.

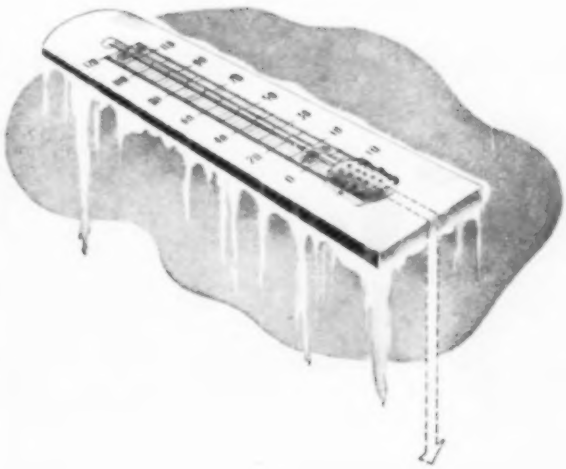
From the time that controls were removed, prices for oils and fats pursued a rising curve with consuming demand running high and supplies of the raw materials too low to satisfy all requirements. In the summer months the influence of new crop cottonseed exerted a bearish influence and a sharp break in prices followed but downward movement was of relatively short duration and in recent weeks, oils and fats have been working back towards the former price levels.

In connection with prices for oils and fats, it was announced last month that the Bureau of Agricultural Economics, under the Research and Marketing Act of 1946, will conduct research into factors affecting prices of oils, fats, and peanuts. This study will include the making of forecasts in appraising the outlook as an aid to guide farmers in planning acreage. Such forecasts also are regarded as valuable to producers, handlers, and consumers of oils and fats.

In addition to prices, the study will deal with the factors which are important in measuring the volume of prospective consumption.

for HIGH STRENGTH

at low temperatures



REVERE COPPER and COPPER ALLOYS

● Revere Copper and copper-base alloys are a "natural" when dealing with applications involving subnormal temperatures all the way down to liquid oxygen (-306°F.) and below.

Copper and its alloys possess the valuable characteristics of becoming increasingly stronger, the lower the temperature, *with no attendant loss of ductility,* and *with no tendency toward brittleness or "notch-impact" sensitivity.*

For example, note the rise in strength, ductility *and* resistance to impact for two copper and brass alloys:

Alloy	Temp. °F.	Tensile Strength, p.s.i.	Elongation % in 2 in.	Impact Resistance, Kg-m per sq. cm.
Electrolytic				
Tough Pitch	68	58,700	8.4	6.6
Copper (Cold Rolled Strip)	-295	64,800	11.2	7.4
Yellow Brass	73	85,400	6.3	8.1
(Cold Rolled Strip)	-295	102,900	10.1	9.4

Other Revere Alloys, such as Herculoy (High-Silicon Bronze, A), show similar improvement in these important mechanical properties.

If you make or are contemplating the manufacture of liquid oxygen equipment, you will be playing safe to specify copper-base alloys. Get in touch with Revere for full information on the low-temperature physical characteristics of Revere metals.

• • •

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N. Y.

Sales Offices in Principal Cities. Distributors Everywhere.

Production of Certain Chemicals in the West for 1946[1]

Chemical	Number of Producing Plants	Western Production — Total	Western Production — Percentage of Total U. S.
Carbon dioxide, liquid & gas, M lb	11	12,361	5.6
Carbon dioxide, soild, M lb	14	112,522	17.4
Chlorine gas, short tons	5	121,789	10.4
Hydrogen, M cu. ft.	13	1,889,000	10.7
Nitric acid, 100%, short tons	6	50,362	8.8
Oxygen, M cu. ft.	27	1,036,000	9.6
Soda ash, natural (Na_2CO_3 equiv.), tons	4	209,411	4.7[2]
Sodium hydroxide, electrolytic liquid, 100%, tons	4	110,383	5.9[3]
Sulphuric acid, contact & chamber, 100%, tons	16	588,336[4]	6.7

[1] For 11 Western States. Bureau of the Census. With the exception of sulphuric acid, these are the first official figures ever released by the Census Bureau on production of such chemicals in the West. [2] As percentage of United States production of total wet and dry by ammonia-soda process plus natural. [3] As percentage of United States production of liquid caustic by electrolytic and lime-soda processes. [4] Excludes fortified spent acid.

United States Production of Certain Chemicals

July 1947, July 1946 and Seven-Month Totals for 1947 and 1946

Chemical (Tons unless otherwise noted)	July 1947	July 1946	Total, Seven Months 1947	Total, Seven Months 1946
Ammonia, synthetic anhydrous[1]	93,345	65,048	638,783	328,919
Ammonium nitrate (100% NH_4NO_3)	87,253	62,658	613,846	304,481
Ammonium sulphate, synthetic technical (M lb.)	36,793	23,185	226,634	174,843
Calcium arsenate ($Ca_3(AsO_4)_2$) (M lb.)	10,458	6,438	31,604	20,703
Calcium carbide, commercial	53,388	48,716	358,192	298,583
Calcium phosphate:				
Monobasic (100% $CaH_4(PO_4)_2$) (M lb.)	6,106	6,485	40,005	40,284
Dibasic (100% $CaHPO_4$) (M lb.)	4,713	5,829	44,052	46,571
Carbon dioxide:				
Liquid and gas (M lb.)	26,502	20,741	136,791	122,638
Solid (M lb.)	83,726	67,396	420,752	370,220
Chlorine	114,676	98,314	788,340	650,433
Chrome green (C. P.) (M lb.)	1,153	1,416	8,167	11,411
Chrome yellow and orange (C. P.) (M lb.)	4,446	3,471	28,176	27,397
Hydrochloric acid (100% HCl)	33,577	27,960	244,287	189,020
Hydrogen (M cu. ft.)	1,816,000	1,474,000	11,650,000	9,744,000
Lead arsenate, acid and basic (M lb.)	447	1,848	24,018	44,940
Molybdate chrome orange (C. P.) (M lb.)	203	430	2,535	2,996
Nitric acid (100% HNO_3)	60,227	57,066	442,383	273,124
Oxygen (M cu. ft.)	1,066,000	904,000	7,818,000	5,787,000
Phosphoric acid (50% H_3PO_4)	87,116	65,858	584,300	503,765
Soda ash:				
Ammonia-soda process:				
Total wet and dry[2]	377,976	361,056	2,630,164	2,425,728
Finished light[3]	183,175	172,259	1,274,887	1,191,462
Finished dense	139,738	131,776	957,715	856,675
Natural[4]	23,811	18,729	152,946	118,573

(*Continued on page 292*)

Skylift Wins on "Point Test!"

COMPARISON PROVES

Feature for feature Skylift Outpoints All Other Fork Trucks

1 The only hydraulic electric truck with automotive type controls:

Operates like a car—anyone who has driven an automobile, can operate the Skylift!

2 Single operating handle for lift and tilt control:

Simplicity of control. Lever, just below steering wheel similar to gearshift lever on newer model cars. Speeds operation—reduces operator fatigue.

3 Can lift, tilt and drive simultaneously or independently under all load conditions:

Speeds operation. Provides easier and faster spotting of loads since lifting and tilting can be accomplished while Skylift is in motion.

4 Forks elevate full height of first lift without increasing overall height:

Forks and uprights move independently to give you full 67 inch single lift before increasing upright height beyond standard 83 inches. Stack to ceiling height in low clearance buildings and boxcars without uprights extending above load.

5 Automatically controlled pre-set lowering speed:

Eliminates possibility of damage to load caused by excessive lowering speeds. No danger of load dropping violently.

6 130" lift with 83" collapsed height of uprights:

New high in lifts for fork truck with standard 83" overall collapsed height of uprights. Higher storage possible, still truck will pass through standard 7 foot high door.

7 Dual chains are load equalized and fully compensated:

Safety—longer chain life. 2 separate chains are used instead of double width chain. Each chain has sufficient capacity to hold load.

8 Fork carriage equipped with special design thrust rollers:

Prevents upright spreading. Also if off center loads are handled, fork carriage will not twist.

9 Reversible drive wheels:

Off center mounting provides increased overall width dimension when drive wheels are reversed ... greater stability on rough or uneven runways.

10 All wheels demountable without disrupting wheel bearing adjustment:

When wheels are removed for tire replacement, bearing alignment cannot be disturbed.

11 Full magnetic contactor control:

Foolproof operation—Truck is either in speed or out of speed. No burning or arcing in controller. Increases life of electrical equipment.

12 Automatically timed master controller (NEWmatic):

Provides automatically timed sequence of four speeds in forward and reverse directions. Completely eliminates tendency of truck operator to start in higher speed, since NEWmatic controller allows truck to start *only* in first speed and pass through faster speeds *only* in proper sequence. Smooth starting, reversing, or accelerating eliminates tire slippage. Reduces peak electric current surges by two-thirds.

13 Foot accelerator pedal for speed control:

Automotive type control—speeds up operation. Simplicity.

14 Disc type brake:

Smoother, easier, positive stopping. Equalized braking power under all operating conditions. Self-aligning for long life.

15 Automatic tilt stops in backward, vertical and forward positions:

Safety. Uprights always centered at vertical position when moving either backward or forward. Reduces possibility of load spilling.

16 Silicone Varnish for motor insulation:

Virtually eliminates possibility of damage to motors from overheating. Applied over glass, mica, or asbestos, it is thus the most effective insulation known to electrical engineers.

Plus These All-Star Features

Dead-man control • Caster-type steering axle • Center control • Operator's position accessible from both sides • Low center of gravity.

NO OTHER FORK TRUCK HAS THESE 16 EXCLUSIVE FEATURES

Skylift
ELECTRIC TRUCK
A PRODUCT OF AUTOMATIC
Lightens LIFE'S LOADS

ONLY AUTOMATIC MAKES THE FAMOUS SKYLIFT ELECTRIC TRUCKS, TRANSPORTERS AND TRANSTACKERS

Send Coupon for "POINT-TEST" Proof of Material Handling Savings

AUTOMATIC TRANSPORTATION COMPANY
DIV. OF THE YALE & TOWNE MFG. CO.
49 W. 87th St., Dept. T-7, Chicago 20, Ill.

☐ Please send me "POINT-TEST" Proof of Skylift material handling superiorities.
☐ Have an ATCO Specialist make a free survey of my material handling costs.
☐ Schedule me for a showing of ATCO's new film, "Pay Loads Pay Off."

Company Name.....
By.....
Street Address.....
City.....State.....

U. S. Production of Certain Chemicals (Cont. from page 290)

Chemical	July 1947	July 1946	Total, Seven Months 1947	Total, Seven Months 1946
June 1947, June 1046 and Six-Month Totals for 1947 and 1946				
Sodium bicarbonate, refined	14,135	15,013	119,906	107,512
Sodium bichromate and chromate	7,331	6,864	49,382	51,838
Sodium hydroxide:				
Electrolytic process:				
Liquid[3]	111,514	95,638	786,480	630,963
Solid	20,736	15,994	134,717	109,762
Lime soda process:				
Liquid[3]	63,893	64,709	443,546	427,589
Solid	21,091	19,495	142,986	124,835
Sodium phosphate:				
Monobasic (100% NaH_2PO_4)	1,187	952	8,356	6,577
Dibasic (100% Na_2HPO_4)	6,640	4,189	44,776	33,059
Tribasic (100% Na_3PO_4)	8,217	7,913	50,416	55,408
Meta (100% $NaPO_3$)	2,864	2,284	17,401	14,950
Tetra (100% $Na_4P_2O_7$)	4,388	3,802	29,930	30,635
Sodium silicate, anhydrous	37,405	39,224	277,217	230,754
Sodium sulphate:				
Anhydrous, refined	10,135	11,307	80,680	73,508
Glauber's salt[4]	13,967	12,724	117,105	95,142
Salt, crude, commercial[5]	50,478	42,945	361,495	304,368
Sulphuric acid:[7]				
Chamber process	252,946	222,919	1,929,994	1,724,544
Contact process, new	540,569	458,352	3,836,236	3,124,918
Zinc yellow (zinc chromate) (C. P.)	355	247	1,857	.....

Data for this tabulation have been taken from "Facts for Industry" series issued by Bureau of the Census. Production figures represent primary production and do not include purchased or transferred materials. Quantities produced by government-owned arsenals, ordnance works, and certain plants operated for the government by private industry are not included. Chemicals manufactured by TVA, however, are included. All tons are 2,000 lb. Where no figures are given data are either confidential or not yet available. [1]Includes a small amount of aqua ammonia. [2]Total wet and dry production, including quantities diverted for manufacture of caustic soda and sodium bicarbonate, and quantities processed to finish light and flinised dense. [3]Not including quantities converted to finish dense. [4]Data collected in cooperation with the Bureau of Mines. [5]Figures represent total production of liquid material, including quantities evaporated to solid caustic and reported as such. [6]Includes oleum grades, excludes spent acid. [7]Data for suphuric acid manufactured as a byproduct of smelting operations are included. [8]Revised.

United States Production of Certain Synthetic Organic Chemicals

June 1947, June 1946 and Six-Month Totals for 1947 and 1946

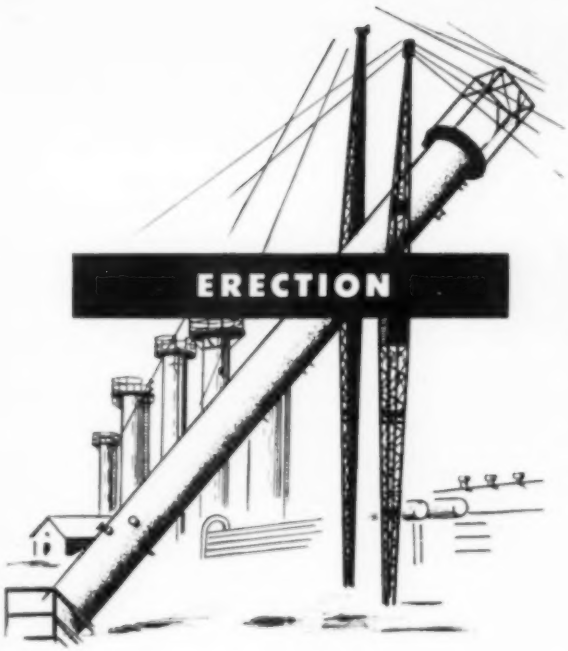
Chemical	June 1947	June 1946	Total, Six Months 1947	Six Months 1946
Acetanilid, Technical and U. S. P.	78,106	624,448	4,269,293	3,515,476
Acetic acid:				
Synthetic[1]	29,843,273	23,537,444	183,162,152	133,336,206
Recovered	93,770,807	93,380,010	702,631,489	571,909,262
Natural[2]	1,885,238	2,475,544	12,258,694	12,803,130
Acetic anhydride[3]	41,433,264	42,545,646	297,793,614	256,183,189
Acetone	34,669,369	27,756,869	219,538,014	160,781,715
Acetylsalicylic acid	1,155,444	676,315	6,031,369	5,561,643

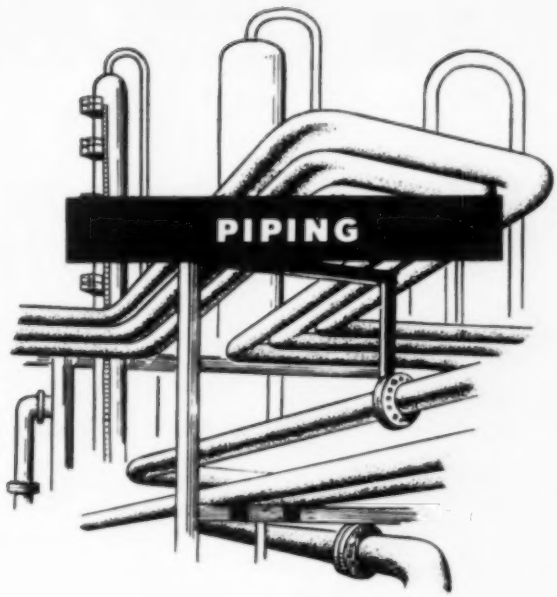
(continued on page 294)

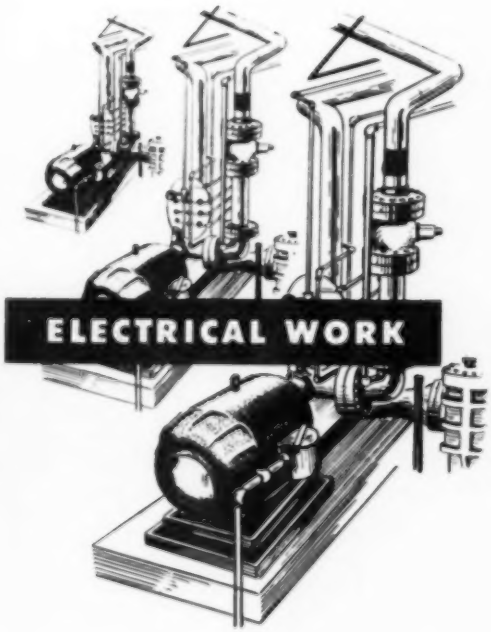
U. S. Production of Synthetic Organic Chemicals (Cont. from page 292)

Chemical	June 1947	June 1946	Total, 1947	Six Months 1946
Aniline	9,692,065	6,958,657	55,012,789	41,417,529
Barbituric acid derivatives[3]				
5-Ethyl-5-phenylbarbituric acid and salts (phenobarbital)	39,002	29,115	230,338	195,384
Benzene:				
Motor grade:				
Tar distillers[4]	.....	707,589	.....	5,375,805
Coke-oven operators[5]	1,339,105	3,527,819	10,936,224	13,780,685
All other grades:				
Tar distillers[4]	1,502,583	2,064,339	13,191,781	13,104,405
Coke-oven operators[5]	11,332,667	8,269,294	73,653,800	48,439,290
Butyl alcohol, primary, normal	11,012,585	7,340,500	82,188,598	50,018,393
Carbon bisulphide	29,328,736	26,032,302	272,797,736	146,601,337
Carbon tetrachloride	16,935,853	11,301,323	99,633,060	68,310,286
Chlorobenzene, mono	30,773,625	22,497,058	158,429,918	134,049,195
Creosote oil:				
Tar distillers[4]	9,559,375	8,214,024	64,071,798	54,925,412
Coke-oven operators[5]	3,219,217	1,923,136	18,748,107	10,713,839
Cresols:				
Meta-para	640,183	134,701	2,930,510	2,066,561
Ortho-meta-para	730,111	587,368	4,786,527	.....
Cresylic acid, refined[7, 10]	1,908,809	1,902,690	13,010,985	10,280,912
Dibutyl phthalate	2,038,463	868,480	10,730,288	.....
Dichlorodiphenyltrichloroethane (DDT)	5,390,231	3,543,018	36,999,340	21,853,296
Ethyl acetate (85%)	6,836,497	6,842,137	44,080,618	41,915,178
Ethylene glycol	18,183,883	.....	.....	.....
Ethyl ether	3,447,208	3,386,276	22,088,740	20,256,387
Formaldehyde (37% by wt.)	44,374,648	30,602,843	269,063,154	224,309,227
Methanol:				
Natural[8]	1,177,504	1,315,384	8,184,889	7,867,543
Synthetic	43,407,186	30,080,933	268,378,154	226,436,637
Naphthalene:				
Tar distillers, less than 79° C.	18,111,627	13,493,120	107,097,183	85,208,437
Tar distillers, 79° C. and over	9,239,964	6,999,214	61,840,535	43,158,824
Coke-oven operators less than 79° C.	9,090,338	5,156,065	46,416,891	26,201,938
Penicillin[9]	3,412,630	2,170,748	16,265,308	12,491,468
Phenol, synthetic and natural	23,986,649	18,322,061	133,141,486	100,324,562
Phthalic anhydride	11,763,884	7,739,056	66,119,380	51,116,013
Styrene, government and private plants	23,281,493	34,833,300	152,426,554	182,967,934
Toluene, coke-oven operators	3,090,799	1,113,301	23,007,013	7,851,849
Toluene, all other[3]	1,366,381	1,486,686	13,791,204	6,574,824

All data in pounds except benzene (gal.) creosote oil (gal.), toluene (gal.) xylene (gal.) and penicillin (million Oxford units). Statistics collected and compiled by U. S. Tariff Commission except where noted. Absence of data on production indicates either that returns were unavailable or confidential. [1]Excludes the statistics on recovered acid. [2]Acid produced by direct process from wood and from calcium acetate. [3]All acetic anhydride including that from acetic by vapor-phase process. [4]Product of distillers who use purchased coal tar only or from oil-gas or water-gas produced or purchased by tar distillers. [5]Statistics are given in terms of bulk medicinals only. [6]Statistics collected by Bureau of Mines. [7]Total production including data reported both by coke-oven operators and by distillers of purchased coal tar. [8]Reported to U. S. Bureau of the Census. [9]Includes toluene produced from petroleum by any process. [10]Includes refined cresylic acid from petroleum.







Whatever the job calls for

The construction of new facilities or the expansion and modernization of existing plants calls for many varied types of work. These three . . . erection of heavy vessels, piping and electrical installation . . . are certain to be included. Foundations, brick work, structural steel and equipment setting will also be called for. Whatever the job requires, Graver's General Construction Division is prepared to do . . . efficiently and thoroughly.

This specialized division of the Graver Tank & Mfg. Co., Inc. includes a seasoned engineering staff, a corps of trained supervisory employees and all the necessary construction equipment. From start to finish, from planning to operation, make your next construction job a Graver job.

GENERAL CONSTRUCTION DIVISION

GRAVER TANK & MFG. CO. INC.

GRAVER

NEW YORK · CHICAGO · PORT ARTHUR, TEX.

SERVING THE
PETROLEUM, CHEMICAL AND PROCESS INDUSTRIES
THROUGH THE CONSTRUCTION OR EXPANSION
OF PRODUCTION FACILITIES

CHEMICAL ENGINEERING Weighted Index of Prices for CHEMICALS

Base = 100 for 1937

As of October 1	**124.94**
Last month (revised)	123.51
October, 1946	111.82
October, 1945	108.72

CURRENT PRICES

The accompanying prices refer to round lots. Where it is trade custom to sell f.o.b. works, quotations are so designated. Prices are corrected to October 1.

INDUSTRIAL CHEMICALS

Acetone, tank, lb.	$0.07 - $0.09
Acid, acetic, 28%, bbl., 100 lb.	3.78 - 4.03
Boric, bbl., ton	124.00 -142.50
Citric, drums, lb.	.24½- .26
Formic, cbys., lb.	.12 - .14
Hydrofluoric, 30%, drums, lb.	.08 - .085
Lactic, 44% tech., light, bbl., lb.	.0815- .0855
Muriatic 18%, tanks, 100 lb.	1.00 -
Nitric, 38°, carboys, lb.	.05 - .05½
Oleum, tanks, wks., ton	19.50 - 20.00
Oxalic, crystals, bbl., lb.	.13 - .14
Phosphoric tech., tanks, lb.	.0465-
Sulphuric, 60°, tanks, ton	13.00 -
Tartaric, powd., bbl., lb.	.49½- .50
Alcohol, amyl from pentane, tanks, lb.	.151-
Alcohol, butyl, tanks, lb.	.17 - .29
Alcohol, ethyl, denatured, No. 1 special tanks, gal.	.87 -
Alum, ammonia, lump, lb.	.04½-
Aluminum sulphate, com. bags, 100 lb.	1.15 - 1.25
Ammonia, anhydrous, cyl., lb.	.16 - .20
tanks, ton	59.00 - 61.50
Ammonium carbonate, powd., casks, lb.	.09½- .10
Sulphate, wks., ton	35.00 - 38.00
Amyl acetate, tech. from pentane, tanks, lb.	.21 -
Aqua ammonia, 26°, drums, lb.	.03 - .03½
tanks, ton	65.00 -
Arsenic, white powd., bbl., lb.	.06 - .07
Barium carbonate, bags, ton	67.50 - 75.00
Chloride, bags, ton	85.00 - 90.00
Nitrate, casks, lb.	.11½- .12
Blanc fixe, dry, bags, ton	67.50 - 72.50
Bleaching powder, f.o.b., wks., drums, 100 lb.	2.75 - 3.00
Borax, gran., bags, ton	48.50 - 66.00
Calcium acetate, bags, 100 lb.	3.00 -
Arsenate, dr., lb.	.09½- .10
Carbide, drums, ton	50.00 -
Chloride, flake, bags, del., ton	21.50 - 38.00
Carbon bisulphide, drums, lb.	.05½- .06½
Tetrachloride, drums, lb.	.06½- .07
Chlorine, liquid, tanks, wks., 100 lb.	2.00 - 2.30
Copperas, bgs., f.o.b., wks., ton	17.00 - 18.00
Copper carbonate, bbl., lb.	.24 - .27
Sulphate, bags, 100 lb.	7.60 - 7.75
Cream of tartar, bbl., lb.	.41½- .42
Diethylene glycol, dr., lb.	.15 - .16
Epsom salt, dom., tech., bbl., 100 lb.	2.05 - 2.25
Ethyl acetate, tanks, lb.	.12 - .16
Formaldehyde, 30%, dr., wks., lb.	.0545-
Furfural, tanks, lb.	.09½-
Glaubers salt, bag, 100 lb.	1.25 - 1.50
Glycerine, c.p., drums, extra, lb.	.29½- .30
Lead:	
White, basic carbonate, dry casks, lb.	.15½-
Red, dry, sck., lb.	.176 - .18
Lead acetate, white crys., bbl., lb.	.19½- .20½
Arsenate, powd., bags, lb.	.21½- .22
Lithopone, bags, lb.	.06 - .06½
Magnesium carb., tech., bags, lb.	.07½- .08
Methanol, 95%, tanks, gal.	.60 -
Synthetic, tanks, gal.	.24 - .29
Phosphorus, yellow, cases, lb.	.22 - .25
Potassium bichromate, bags, lb.	.11½- .11½
Chlorate, powd., lb.	.09 - .09½
Hydroxide (c'stic potash) dr., lb.	.07½- .09½
Muriate, 60%, bags, unit	.37½- .45½
Nitrate, ref., bbl., lb.	.08½- .12
Permanganate, drums, lb.	.20½- .21½
Prussiate, yellow, casks, lb.	.19 - .20
Sal ammoniac, white, casks, 100 lb.	4.75 - 5.00
Salsoda, bbl., 100 lb.	1.10 - 1.20
Salt cake, bulk, ton	20.00 - 25.00
Soda, ash, light, 58%, contract, bags, 100 lb.	1.30 -
Dense, bags, 100 lb.	1.38 -
Soda, caustic, 76% solid, drums, 100 lb.	2.60 -
Acetate, del., lb.	.05½- .06
Bicarbonate, bags, 100 lb.	2.25 -
Bichromate, bags, lb.	.09 - .09½
Bisulphate, bulk, ton	20.00 - 24.00
Bisulphite, bbl., lb.	.03 - .04

CHEMICAL ENGINEERING

Weighted Index of Prices for OILS & FATS

Base = 100 for 1937

As of October 1	251.70
Last month	200.79
October, 1946	161.52
October, 1945	145.63

Chlorate, kegs, lb.	$0.06½ - $0.08
Cyanide, cases, dom., lb.	.14½ - .15
Fluoride, bbl., lb.	.09½ - .09½
Hyposulphite, bags, 100 lb.	2.75 - 3.15
Metasilicate, bbl., 100 lb.	3.40 - 4.00
Nitrate, bulk, ton	32.00 - 38.50
Nitrite, casks, lb.	.06½ - .07
Phosphate, tribasic, bags, 100 lb.	3.50 - 4.00
Prussiate, yel., bags, lb.	.12 - .12½
Silicate, 40°, dr., wks., 100 lb.	.95 - 1.00
Sulphite, crys, bbl., lb.	.03 - .04
Sulphur, crude at mine, long ton	16.00 - 18.00
Dioxide, cyl., lb.	.085- .09
Dioxide, tanks, lb.	.044-.....
Tin crystals, bbl., lb.	.55 -.....
Zinc chloride, gran., bbl., lb.	.07 - .07½
Oxide, lead free, bags, lb.	.10 - .10½
Oxide, 35%, leaded, bags, lb.	.11½ - .12
Sulphate, bags, cwt.	4.15 - 7.00

OILS AND FATS

Castor oil, No. 3 dr., lb.	$0.26½-.....
Chinawood, oil, tanks, lb.	.22½-.....
Coconut oil, ceylon, N. Y., lb.	.19 -.....
Corn oil, crude, tanks, (f.o.b. mill), lb.	.24 -.....
Cottonseed oil, crude (f.o.b. mill), tanks, lb.	.22½-.....
Linseed oil, raw, car lots, dr., lb.	.294-.....
Palm, casks, lb.	nom.
Peanut oil, crude, tanks (mill), lb.	.23 -.....
Rapeseed oil, refined, bbl., lb.	nom.
Soybean, tanks, lb.	.22½-.....
Menhaden, light, pressed dr., lb.	.20 -.....
Crude, tanks (f.o.b. factory), lb.	.18 -.....
Grease, yellow, loose, lb.	.18½-.....
Oleo stearine, lb.	nom.
Oleo oil, No. 1, lb.	.25 -.....
Red oil, distilled, bbl., lb.	.26½-.....
Tallow, extra, loose, lb.	.19½-.....

COAL TAR PRODUCTS

Alpha-naphthol, crude, bbl., lb.	$0.64 - $0.66
Alpha-naphthylamine, bbl., lb.	.35 - .36
Aniline oil, drums, lb.	.14 - .15
Aniline salts, bbl., lb.	.22 - .24
Benzaldehyde, tech., dr., lb.	.45 - .50
Benzidine base, bbl., lb.	.77 - .78
Benzoic acid, USP, kegs, lb.	.54 - .56
Benzol, 90% tanks, works, gal.	.19 - .21
Benzyl chloride, tech., dr., lb.	.20 - .21
Beta-naphthol, tech., drums, lb.	.23 - .24
Cresol, USP, dr., lb.	.14½- .15½
Cresylic acid, dr., wks., gal.	1.25 - 1.30
Diphenyl, bbl., lb.	.15 - .16
Diethylaniline, dr., lb.	.48 - .50
Dinitrotoluol, bbl., lb.	.18 - .19
Dinitrophenyl, bbl., lb.	.22 - .23
Dip oil, 15%, dr., gal.	.23 - .25
Diphenylamine, dr., f.o.b. wks., lb.	.25 -.....
H acid, bbl., lb.	.80 - .82
Hydroquinone, bbl., lb.	.90 - .95
Naphthalene, flake, bbl., lb.	.11 - .11½
Nitrobenzene, dr, lb.	.08½- .09
Para-Cresol, bbl., lb.	.41 - .60
Para-nitroaniline, bbl., lb.	.42 - .43
Phenol, USP, tanks, lb.	.11 - .11½
Picric, acid, bbl., lb.	.30 - .32
Pyridine, dr., gal.	1.55 - 1.60
Resorcinol, tech., kegs, lb.	.68 - .70
Salicylic acid, tech., bbl., lb.	.30 - .35
Solvent naphtha, w.w., tanks, gal.	.25 -.....
Toluidin, bbl., lb.	1.00 -.....
Toluol, drums, works, gal.	.23 -.....
Xylol, com., tanks, gal.	.25 -.....

MISCELLANEOUS

Casein, etch., bbl., lb.	$0.32 - $0.35
Dry colors:	
Carbon gas, black (wks.), lb.	.04 - .07
Prussian blue, bbl., lb.	.42 - .43
Ultramarine blue, bbl., lb.	.13 - .24
Chrome green, bbl., lb.	.32 - .42
Carmine red, tins, lb.	5.50 - 6.00
Para toner, lb.	.80 - .95
Vermilion, English, bbl., lb.	2.50 - 2.70
Chrome yellow, C. P., bbl., lb.	.26 - .28
Gum copal, Congo bags, lb.	.09 - .55
Manila, bags, lb.	.09 - .15
Damar, Batavia, cases, lb.	.10 - .22
Kauri, cases, lb.	.18 - .60
Magnesite, calc., ton	52.75 - 57.00
Pumice stone, lump, bbl., lb.	.05 - .07
Rosin, H., 100 lb.	8.50 -.....
Shellac, orange, fine, bags, lb.	.54 - .56
Bleached, bonedry, bags, lb.	.58 - .60
T. N. bags, lb.	.52 - .54
Turpentine, gal.	.75 -.....

NEW CONSTRUCTION

	Current Projects		Cumulative 1947	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	.....	.....	$8,961,000	$2,431,000
Middle Atlantic	$800,000	$750,000	7,792,000	23,010,000
South	10,677,000	4,045,000	22,258,000	41,994,000
Middle West	.....	1,508,000	16,592,000	19,183,000
West of Mississippi	15,150,000	13,435,000	253,452,000	117,919,000
Far West	1,000,000	700,000	5,206,000	12,666,000
Canada	.....	.....	37,323,000	18,150,000
Total	$27,627,000	$20,438,000	$351,584,000	$235,353,000

Proposed Work

Fla., Carrabelle—Mobile Paper Co., Mobile, Ala., is having plans prepared for the construction of a complete pulp mill in this vicinity. Estimated cost $10,000,000.

Kan., Topeka—Snyder Chemical Co., 3636 West 36th St., plans to construct a commercial fertilizer manufacturing plant. Estimated cost $150,000.

Ky., Morehead—Tennessee Gas & Transmission Co., Commerce Bldg., Houston, Tex., plans to construct an experimental compressor station to have a capacity of 350,000 cu. ft. daily. Estimated cost $477,000.

N. Y., Olean—Keystone Gas Co., Olean, plans to construct a new propane-air gas plant on Reed St., including 12 steel tanks to have a capacity of 360,000 gal. Estimated cost $300,000.

Ore., Springfield—Weyerhauser Timber Co., Tacoma Bldg., Tacoma, Wash., plans to construct a sulphate plant. Estimated cost $1,000,000.

Pa., Lancaster—Armstrong Cork Co., Lancaster, plans to construct a laboratory and research building and pilot plants. Shreve, Lamb & Harmon, 11 East 44th St., New York, N. Y., Archts. Estimated cost $500,000.

Tex., Brownsville—Standard Oil Co., of Indiana, 910 South Michigan Ave., Chicago, Ill., and Tulsa, Okla., plans to construct a chemical plant for hydro-carbon chemicals. Estimated cost $13,500,000.

Tex., Port Arthur—Gulf Oil Corp. plans to enlarge its refinery here. Estimated cost $1,500,000.

Va., Newport News—Asheville Mica Co., Asheville, N. C., plans to construct a 1-story factory and a 1 story administration building. Wilkieams, Coile & Pipino, Newport News. Archts. Estimated cost $200,000.

Contracts Awarded

Ala., Sheffield — Electrometallurgical Co., Sheffield, has awarded the contract for a furnace building to Kershaw Contracting Co., 2212 20th Ave., S. Birmingham, Ala. Estimated cost $260,000.

Ark., Arkansas City—Kanotex Refining Co., Arkansas City, has awarded the contract for modernizing its refinery to Koch Engineering Co., Arkansas City. Estimated cost $375,000.

Calif., Oleum—Union Oil Co., 425 First St., San Francisco, has awarded the contract for a 1 story, 180x187 ft. warehouse to MacDonald, Young & Nelson, 127 Montgomery St., San Francisco. Estimated cost $300,000.

Ill., Cicero—Socony-Vacuum Oil Co., 59 East Van Buren St., Chicago, Ill., has awarded the foundation and piling contract for a blending plant and gasoline warehouse to R. R. Anderson Co., 228 N. La Salle St.; masonry to G. G. Construction Co., 5153 N. Clark St., both of Chicago. Estimated cost $1,000,000.

Ind., East Chicago—E. I. du Pont de Nemours & Co., Inc., du Pont Bldg., Wilmington, Del., has awarded the contract for the design and construction of a plant here to F. H. McGraw, 780 Windsor St., Hartford, Conn.

Kan., Kansas City—Phillips Petroleum Co., Bartlesville, Okla., has awarded the contract for a 2 story, 300x500 ft. compounding plant to Winn-Senter Construction Co., Railway Exchange Bldg., Kansas City, Mo. Estimated cost will exceed $500,000.

Ky., Louisville — Interchemical Co., c/o Struck Construction Co., contractor, 147 North Clay St., will construct a warehouse. Estimated cost will exceed $55,000.

Ky., Louisville—Mason Paint Co., 729 Roselane, has awarded the contract for a plant to L. V. Abbott, 2323 South Brook St. Estimated cost $130,000.

La., Delhi—Sun Oil Co. & Associates, Walnut St., Philadelphia, Pa., have awarded the contract for a natural gasoline extraction plant to Petroleum Engineering, Inc., Commerce Bldg., Houston. Estimated cost $2,750,000.

Mich., Jackson—Goodyear Tire & Rubber Co., Jackson, has awarded the contract for a power house addition at its tire plant to Birmingham Construction Co., 208 Hanna Bldg., Birmingham, Mich. Estimated cost $148,000.

Mich., Trenton — Monsanto Chemical Co., Trenton, has awarded the contract for a machine shop and storage building to Kuhne & Simons Construction Co., 1048 Penobscot Bldg., Detroit. Estimated cost $250,000.

Mont., Billings—Continental Oil Co., 39 Bruckner Blvd., New York, N. Y., and Tulsa, Okla., has awarded the contract for a refinery here to Jones & Laughlin Supply Co., 108 North Trenton St., Tulsa, Okla. Estimated cost $8,500,000.

N. Y., Buffalo—E. I. du Pont de Nemours & Co., Inc., River Rd., has awarded the contract for a new research laboratory building to George W. Walker & Sons 770 Elmwood Ave. Estimated cost $500,000.

Ore., Portland—Fireboard Products, Inc., S. E. Schiller & 24th Sts., has awarded the contract for a plant to L. H. Hoffman, 715 S. W. Columbia St. Estimated cost $400,000.

Pa., Falls Creek—Jackson Vitrified China Co., 1 West 34th St., New York, N. Y. has awarded the contract for an addition to its factory here to W. E. Clark, Johnsonburg, Pa. Estimated cost $95,000.

Pa., Fort City—Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh, has awarded the contract for a 1 story, 78x150 ft. addition to its plant to The Austin Co., 16112 Euclid Ave., Cleveland, O., Estimated cost $100,000.

Pa., Stockertown—Hercules Cement Corp., 1320 Walnut St., Philadelphia, will modernize and alter its plant. Work will be done by owner. Estimated cost will exceed $55,000.

Tenn., Columbia—Monsanto Chemical Co., 1700 South Second St., St. Louis, Mo., will construct an extension to its furnace building, erect service buildings and alter existing buildings for elemental phosphorous production plant. Work will be done on subontract basis under supervision of Engineering Department, Phosphorous Div., Anniston, Ala. Estimated cost $500,000.

Tex., Beeville—Western Natural Gas Co., c/o H. Coquat, Milam Bldg., San Antonio, has awarded the contract for a recycling plant to Refinery Maintenance Service Co., Inc., Portland. Estimated cost $450,000.

Tex., Houston—Shell Oil Co., Shell Bldg., has awarded the contract for an addition to its plant to E. Lee Bond, 3707½ Ingold St. Estimated cost $110,000.

Tex., Oakville—Western Natural Gas Co., Chronicle Bldg., Houston, has awarded the contract for a processing plant to Refinery Maintenance Corp., Compton, Calif. Estimated cost $750,000.

Tex., Wink—Richardson & Bass & Associates, National Bank Bldg., Fort Worth, have awarded the contract for a natural gasoline plant to Jones & Laughlin Supply Co., 108 North Trenton St., Tulsa, Okla. Estimated cost $1,750,000.

W. Va., Mannington—Mannington Pottery Co., Mannington, has awarded the contract for remodeling its factory to D. F. Nellis & Sons Co., St. Clair Ave., East Liverpool, O. Estimated cost $350,000.

Wis., Eau Claire—Sterling Pulp & Paper Co., Eau Claire, will construct a 2 story, 68x108 ft. warehouse. Work will be done by day labor.